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Em-Space and Renewal-at-π Cosmology (A Revisit of Space and Gravity)

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Abstract

Em-space and renewal-at-π cosmology (a revisit of space and gravity) is a theory that deals with space, gravity, and cosmology. It is based on two principle notions: the first notion regards space as being made up of energy and therefore having a corresponding mass to it. The term "em-space" is used to denote this "energy–mass" aspect of space. This energy–mass aspect of em-space is based on: (1) the fact that gravity exists as a universal force; the presence of gravity is seen here as the main indication of the energy–mass aspect of em-space; (2) the creation of virtual pairs as observed under vacuum conditions of space; and (3) the measured existence of cosmic microwave background radiation (CBR). In this theory em-space behaves like the interior of a giant, even-temperature oven, where the measured isotropic CBR is the blackbody radiation of the fabric of em-space itself. This is contrary to the assumption of the big bang theory, where the CBR is viewed as being the remnants of a primordial explosion that took place when the universe began.

This theory views em-space as a self-contained and sustained energy–mass system that is oscillatory in nature, expanding and contracting over a very large period of time. The basic structure of the fabric of em-space is unlike that of the matter universe. The fabric of em-space is viewed here as being flexible, stretchable, and resilient so that as it expands and stretches, it stores potential energy. Over time, this fabric of em-space has spread throughout its huge volume so thinly that it is not observable.

The second notion proposes that "gravity" did not exist when em-space was created nor for some time after. In this theory gravity is an inherent quality of em-space, starting from a value of zero when em-space was created and gradually developing in strength as em-space expands. This view is based on the observed fact that the "universe is expanding," because if there had been a primordial explosion in conjunction with a full-strength gravity, no matter how big the explosion, the initial, infinitely dense universe would certainly have collapsed unto itself early on, thus preventing any further expansion and, consequently, its evolution into its present state. In the proposed theory the potential for gravitation is embodied in the expanding fabric of em-space, and it is the interaction of matter with em-space that allows gravity to display itself. Gravity is the representation of the stored potential energy that has been built up in the fabric of em-space throughout its expansion. As em-space expands, the strength of gravity increases, and this theory predicts an annual increase of 3.3447×10^{-18} dyn $\cdot$cm^2 $\cdot$g^{-2} in the universal gravitational constant.

This theory proposes that the present cycle of em-space originated from an energy singularity about 20 billion years ago, not as a result of some sort of explosion, but because of its oscillatory nature. The periodic renewal of em-space is calculated to occur at about every 1000 billion years. With no gravity to hinder it at the outset, em-space was free to expand at the speed of light. It will continue to expand until all of its kinetic energy has been converted to potential energy and stored in its fabric, thereby signaling the end of expansion and the start of contraction.

The matter universe embedded in em-space constitutes only a small percentage (about 1% to 2%) of the total mass of em-space. This "mass" of em-space eliminates the need to find "dark matter" in order to make our universe a closed one. Em-space, with its huge "mass," is the controlling agent of a universe that continuously emerges from a singularity, expands, contracts, and finally reemerges again. Our present universe, which consists of em-space and the embedded matter universe, is only one cycle of this periodic system.

The contraction phase of em-space will end in a pure energy singularity state where its speed of contraction will equal that of light, and gravity will be nonexistent. In view of this envisioned cyclical nature of em-space, this point along the time axis has been labeled as π.

As em-space passes through this transition point, one life cycle of em-space ends and a new one begins (renewal at π).

The presented theory provides alternative views and answers to some of the questions regarding the cosmos, such as the birth and the expansion of the universe, the isotropicity of the cosmic microwave background radiation, and the formation of the super structure of the universe, quasars, and galaxies.

Key words: space, gravity, cosmology, galaxy formation, new theory about space and gravity, a new theory of cosmology, redshift

1. INTRODUCTION

Ever since humans were able to gaze at the sky, everthing that they saw and observed, such as the Sun, the stars, the Milky Way, planets, comets, and the universe itself, has been the subject of their curiosity. People have asked all kinds of questions about the wonders of the universe, such as: What are the Sun and the stars made of? Why are there so many stars in the sky? How far away are they? What is the Milky Way? How far away is it and how large? And the universe itself: Is it infinitely large? How old is it? When did it become the way that it appears to us? Did it have a beginning and will it have an end?

We have tried to explain what we saw and observed in the universe either by religious views, attributing everything to the power of God, or by scientific means, by trying to explain the physical nature of things or by combining both views and explaining the physical nature of things as much as possible with science, while leaving the rest to the power of God.

During the last one hundred years, the advancement of technology used in monitoring and observing the universe has been astronomical indeed. With the help of earth- and space-bound telescopes and other monitoring technology, an unbelievable amount of data have been gathered about objects in the near and far corners of the universe at large. Based on their observations and knowledge, scientists have come up with models to represent the cosmic system, and with the help of these models, they have tried to explain the physical nature of the universe. Currently, there are numerous cosmological models that are widely discussed and that appeal to different segments of the scientific community, but to date, scientists have been unable to produce one comprehensive model that is able to explain all aspects of the observed universe by itself. Some of the widely discussed cosmological models are briefly presented below.

1.1 The Big Bang Model

At present, the most popular theory of cosmology is the so-called big bang theory.[1–3] This "expanding universe theory" was initially postulated by Alexander A. Friedmann, a Russian mathematician, and was later developed further by Georges Lemaître, a Belgian theoretical astronomer. This theory, which was named the big bang by Fred Hoyle, an English cosmologist (with the intention of discrediting it), states that the universe started from a highly compressed and extremely hot state of matter, and due to a gigantic explosion that occurred simultaneously everywhere, the universe started to expand at an early age. With the expansion process the universe cooled and evolved from a state of densely concentrated matter to the presently observed state of the universe.

In the big bang theory the point where the universe started is referred to as an "energy singularity," where all the natural forces of nature are unified. In the singularity the laws of nature somehow break down, and an explosion takes place that overcomes the effects of the unified forces and causes the singularity to expand. As the expanding energy cools down, first gravity separates from the unified single force, and then the other three forces of nature separate from each other.

The advocates of the big bang theory predicted the existence of a cosmic background radiation, which was assumed to be the remnant of this primordial explosion.

The big bang theory is supported by two observed aspects of the universe:

(1) In 1929, astronomer Edwin P. Hubble,[2–4] at the Mount Wilson Observatory, observed that the light received from distant galaxies had redshifts associated with it, and from this study he discovered that the farther away a galaxy was, the greater was the redshift of the light coming from it.

The advocates of the big bang theory interpret this discovery by Hubble as observational proof that the universe is indeed expanding, the galaxies are receding from each other, and the observed redshift of the light from galaxies is due to the Doppler effect, that is, velocity shifts.

(2) The second favorable point for the big bang theory was the discovery, in 1965, of the cosmic background radiation (CBR) by Arno A. Penzias and Robert W. Wilson of Bell Telephone Laboratories. Penzias and Wilson discovered the presence of a CBR being detected in equal strength from all directions of space. Since then, extensive research has been carried out regarding CBR with earth- and space- bound equipment.[5,6] The measurements have established a characteristic temperature of 2.7 K for the CBR. For the proponents of the big bang theory the CBR was the missing fingerprint of the explosion that started the universe expanding.

Among some of the prominent advocates of the big bang theory were G. Gamow, R.A. Alpher, and R.C. Hermann.

After having pointed out the supportive aspects of these discoveries for the big bang theory, however, perhaps we should also note here some other views, regarding the redshift and the CBR, which are alternative explanations of the big bang model of the universe.

First of all, it should be noted here that Hubble, in his book *The Realm of the Nebulae*,[4] did not seem to be wholly convinced of his interpretation of his discovery of the redshifts as an indication of the expansion of the universe. Some of Hubble's views regarding the redshifts are quoted below:

> Although no other plausible explanation of red-shifts has been found, the interpretation as velocity-shifts may be considered as a theory still to be tested by actual observation. (p. 34)

> A completely satisfactory interpretation of red-shifts is a question of great importance, for the velocity-distance relation is a property of the observable region as a whole.

> Several ways are known in which red-shifts might be produced. Of them all, only one will produce large shifts without introducing other effects which should be conspicuous, but which are not observed. This explanation interprets red-shifts as Doppler effects, that is to say, as velocity-shifts, indicating actual motion of recession. It may be stated with some confidence that red-shifts are velocity-shifts or else they represent some hitherto unrecognized principle in physics. (p. 121)

> The interpretation as velocity-shifts is generally adopted by theoretical investigators, and the velocity-distance relation is considered as the observational basis for theories of an expanding universe.

Hubble, after calculating a "magnitude increment Δm" for "motion related" and "no motion related" redshifts states:

> The observed coefficient is smaller here than that in the relation calculated on either interpretation of red-shift, but is much closer to the coefficient representing no motion. Careful examination of possible sources of uncertainties suggests that the observations can probably be accounted for if red-shifts are not velocity-shifts. If red-shifts are velocity-shifts then some vital factors must have been neglected in the investigation. (p. 197)

> ...Thus a negative curvature, implying an open universe, is ruled out, and the possible, expanding universes are restricted to those with positive curvature. If red-shifts are velocity-shifts, it follows that the universe is closed, having finite volume and finite contents....On the other hand, if the interpretation as velocity-redshifts is abandoned, we find in the red-shifts a hitherto unrecognized principle whose implications are unknown. The expanding universe of general relativity would still persist in theory, but the rate of expansion would not be indicated by the observations. (p. 200)

Second, there is the "tired light" view of the observed cosmological redshifts as being due to some kind of interaction of the photon in its journey from a distant galaxy to the Earth; some supporters of this view are scientists such as Regener, Nernst, Finlay–Freundlich, Max Born, and Louis de Broglie. Assis and Neves provide a well-documented account of the views of the proponents of the "tired light" theory and the CBR associated with it in their 1995 paper.[7] This group of scientists believed in a nonexpanding steady-state universe (see Sec. 1.3 below), which was somewhat different from the steady-state universe that was proposed originally by Herman Bondi, Thomas Gold, and Fred Hoyle.

Third, in recent years there have been some studies such as those by James and Wolf,[8,9] indicating that "light scattering on anisotropic media can also cause redshift in light such that it is not distinguishable from the Doppler effect." As interpreted by James and Wolf, the implication of this is that if the universe is filled with empty vacuum, then the observed redshifts of light from galaxies can be attributed to the Doppler effect; on the other hand, if the universe is filled with plasma, then the observed redshifts can be due to scattering of light by the media filling the universe.

The big bang theory, in spite of the successes claimed by its proponents, fails to explain how matter formed into super structures such as conglomerations of galaxies. Guth and Steinhardt, after listing some of the problems of the big bang theory in their article,[10] state that "the inflationary universe was invented to overcome these problems." For example, in addition to the unexplained problem of the large-scale structures of the universe, there are other problems, such as the missing mass and the "horizon problem."[10,11]

The proponents of the big bang theory seem to favor a closed universe. But the gravity due to the mass of the observed matter in the universe is insufficient to stop the universe from expanding forever and reaching a cold, dark state. A certain amount of matter, the so-called "missing mass," is required and sought after to determine not only the fate of the expanding universe, but also to explain the large-scale structures of galaxy formation.

The big bang theory also cannot explain why the universe appears to be uniform with regard to the CBR over distances that are large compared to the horizon distance.[2,10]

The big bang theory assumes that gravity and the other remaining forces of nature ruled the universe from the very beginning of the universe.

1.2 Quasi-Steady-State Cosmological Model

Presently, a second important cosmological model is the so-called "quasi-steady-state cosmological (QSSC) model" proposed by Hoyle, Burbidge, and Narlikar.[12-14] It is basically a modification of the original steady-state theory proposed in 1948 by Bondi, Gold, and Hoyle (Ref. 3, p. 253). In the original steady-state theory matter was being created continuously in order to maintain a constant density of matter in an expanding universe. The QSSC model now postulates that large amounts of matter

are created in "creation centers" by explosions that are called "little big bangs." Hence the matter in the universe which expands forever is replenished by these "little big bangs." These "little big bangs" involve matter creation in the order of 10^{16} times the mass of the Sun, distributed over all space and time in a universe that has no beginning. In QSSC, matter creation takes place only in strong gravitational fields associated with dense aggregates of already existing matter. In QSSC "the expansion rate of the universe is not a constant but can vary secularly, corresponding to the changes in the number and masses of the creation centres which drive the expansion." The model claims to "fit the observational facts of cosmology best when intermittent bursts of creation, occurring at intervals generally of the order H_0^{-1}, where H_0 is the present-day measured expansion rate of galaxies, are interspersed with longer periods of comparatively weak creation, but with the possibility that, viewed over long time intervals, the expansion is an approximately steady process with a generation length of about H_0^{-1}."

1.3 A Steady-State Theory Without Expansion and Without Continuous Creation of Matter

This steady-state model of cosmology, as explained in the paper by Assis and Neves,[7] is somewhat similar to the original steady-state theory proposed by Bondi, Gold, and Hoyle except that it is a nonexpanding universe without the continuous matter creation, and the redshift is attributed to the "tired light" concept rather than the Doppler effect. This model of the universe has been pursued by scientists such as E. Regener (1933), W. Nernst (1937), E. Finlay-Freundlich (1954), Max Born (1954), and Louis de Broglie (1966). The authors of this model predicted the correct value of the temperature of the CBR before it was discovered.

Although the CBR was discovered in 1965, the characteristic temperature of the CBR was calculated long before 1965 by both the expansionists (i.e., those who favored the big bang theory of universe) and the nonexpansionists (i.e., those who favored a steady-state universe without expansion and without continuous matter creation). As pointed out by Assis and Neves, it seems that the temperature of the CBR calculated by the proponents of the nonexpanding steady-state view of the universe was much closer to the measured value of 2.7 K than those values calculated by the proponents of the big bang theory. Assis and Neves give a comparison of the calculated figures that shows the characteristic temperature of the CBR as calculated by nonexpansionists ranging from 1.6 K to 6 K, while those values calculated by the proponents of the big bang theory ranged from 5 K to 50 K.[7]

In view of this, the authors of this model advocating a nonexpanding steady-state universe without continuous matter creation could also claim the discovery of the CBR as supporting evidence of their point of view, since the observed characteristic temperature of the CBR was closer to their own calculations.

1.4 Plasma Universe

Another cosmological theory, advocated by Alfven,[15] Peratt,[16,17] and Lerner,[18,19] proposes that the "...universe is largely matter in its plasma state." Hence the name plasma universe is used. In the plasma universe, mainly the formation of large objects such as galaxies, radio galaxies, quasistellar objects, and stars is formulated. The plasma universe model proposes that the motion of the plasma in local regions along with the presence of electromagnetic fields in space can lead to plasma being pinched, ultimately resulting in plasma condensing into states of matter which in turn lead to the formation of cosmological objects. The plasma universe needs the presence of strong electromagnetism in conjunction with gravity throughout space so that matter in its plasma state can be pinched into filaments and then condense into other states of matter.

Alfven characterizes the plasma universe by stating that

(1) It has a cellular structure.
(2) It may contain antimatter.
(3) It is not created by the conventional big bang.
(4) It is penetrated by a network of currents which transport energy over large distances and produce double layers which accelerate particles to very high energies.
(5) It allows new approaches to the energy release in double radio sources, quasistellar objects, Sieferts, etc.
(6) The plasma is often dusty.
(7) The cosmic plasmas cannot be described by the magnetic field picture alone; they must be supplemented by electric currents in interstellar space.
(8) There are good reasons for the general view that stars and solar systems are born out of interstellar clouds of dusty plasma.

Peratt, using the plasma universe concept, provides the results of his investigations involving the simulations of interactions between plasma pinched into filaments in the universe. A simulation time frame in the order of 10^8 to 10^9 yr is used.

Lerner presents the plasma universe model as an alternative to the conventional big bang hypothesis, as the origin of light elements and the microwave background radiation and assumes that helium, deuterium, and the microwave background radiation were all generated by massive stars in the early stages of galaxy formation. The plasma universe model does not require the big bang for the production of elements.

1.5 The Large-Numbers Hypothesis Cosmology

A cosmological model was also proposed by Dirac, based on Ref. 20. In his model Dirac assumes a time-varying gravity in an expanding universe. After a theoretical model by Shapiro (Ref. 20, p. 8), in which a varying universal gravitational constant G was suggested, Dirac states that if the universal gravitational constant G is varying with time, it must be a decreasing gravity. In Dirac's cosmology one cannot have a universe reaching a maximum size (Ref. 20, p. 12). So one must think of a cosmology in which the universe goes on expanding forever and in which G becomes weaker forever (Ref. 20, p. 13). In Dirac's universe matter is created uniformly throughout the whole of space. Matter is created either in intergalactic space, which he defines as the "additive creation," or in places where matter already exists. This second case is called the "multiplicative creation." Dirac assumes that G is constant in ephemeris time and that it varies against atomic clocks (Ref. 20, p. 9).

2. EM-SPACE AND RENEWAL-AT-π COSMOLOGY

In this paper, with due respect to the giants of this field, I humbly present a cosmological model that I have developed as an alternative view of the universe. I have named my cosmological theory "Em-Space and Renewal-at-π Cosmology (A Revisit of Space and Gravity)." In this model the universe expands and contracts periodically and renews itself at the end of each contraction. It resembles some of the above-cited cosmological models only in the sense that it is an expanding universe at present and will be for a long time (about 500 billion years). After it reaches its maximum size, it will start contracting. The theory presented here offers a new view of space, gravity, and the expansion of the universe. It was first introduced in a self-published and limited edition book in 1993.[21]

2.1 Assumptions of the Theory

In the theory presented here I also propose to start the universe from an energy singularity. However, in my energy singularity all the forces of nature have disappeared and/or have been neutralized rather than unified in one single force. Gravity has diminished to zero. Hence there is a "pure energy singularity" that does not have any force holding it together. In this state energy in the singularity starts radiating at the speed of light and expands in all directions without the need for an explosion. As the energy singularity expands, it cools down, first creating the fabric of space itself and then creating the matter universe in it.

The proposed theory is based on two notions. The first notion regards space itself as being made up of energy and therefore having a corresponding mass to it (hence the name "em-space"). The energy–mass aspect of em-space is based on (1) the fact that gravity exists as a universal force everywhere in space and is independent from the other three remaining forces of nature; (2) the creation of virtual pairs as observed under vacuum conditions of space; and (3) the measured existence of CBR.

This theory views em-space as a self-contained and sustained energy–mass system that is oscillatory in nature, expanding and contracting over a very large period of time. It has a fabric that is unique and special to itself. The basic structure of the fabric of em-space is unlike that of the matter universe. The fabric of em-space is flexible, stretchable, and resilient so that as it expands and stretches, it stores potential energy. Over time, this fabric of em-space has spread throughout its huge volume so thinly that it is not physically measurable.

The second notion of the theory proposes that "gravity" did not exist when em-space was created, nor for some time after. In this theory gravity is not attributed to the mass of the matter universe but rather is an inherent quality of the fabric of em-space itself, starting from a value of zero when em-space was created (at the beginning of each renewal cycle) and gradually developing in strength as em-space expands. In the contraction phase of em-space gravity would slowly decrease in strength until it reached a value of zero, which would coincide with the moment of singularity. This view is based on the observed fact that the "universe is expanding" and on the assumption that an expanding universe is possible only if there were no gravity present at the beginning of the universe. If there had been a primordial explosion in the presence of a full-strength gravity that would have been associated with the mass of a newly born universe, the initial infinitely dense universe would have collapsed unto itself under its own gravity soon after the explosion, thus preventing any further expansion and consequently its evolution into its present state. The fact that the universe is expanding may be construed as an indication that gravity was not present at the birth of the universe. A pure energy source without the presence of gravity could and would radiate outward quite readily without the need for an explosion. A universe born from such a pure state of energy would expand in all directions at once.

In this theory gravity is viewed not only as an inherent feature of em-space, but as the main evidence of the energy–mass aspect of em-space and is shown to be related to the mass embodied in the fabric of em-space. The interaction of matter with the fabric of em-space allows gravity to display itself as an attractive force (see Sec. 8.3).

In the theory presented in this paper the CBR is considered to be the blackbody radiation from the energy–mass fabric of em-space at the observed characteristic temperature of 2.7 K. Em-space itself behaves like the interior of a giant, even-temperature oven radiating equally everywhere and in all directions. These notions will be revisited in various sections of this paper as the concept is developed.

2.2 Fabric of Em-Space

Over billions of years the fabric of em-space has expanded into so large a volume and its energy–mass density has become so small that it has become undetectable. Em-space should not be thought of in terms of a "matter-filled space" but rather in terms of an "energy–mass system" formed in some non-matter-like fabric that makes up em-space. Whatever its actual structure may be, it is totally different from the structure of particles that make up the matter universe. The structure of the energy–mass fabric of em-space is not directly testable or measurable. It can only be speculated about. The expansion of em-space suggests that its fabric is flexible, stretchable, and resilient so that as it expands and stretches, it stores potential energy, much like an expanding spring. It could be said that the fabric of em-space is continuous and indivisible.

Em-space has an associated "mass," although presently its density is very small (see Sec. 6), but when viewed universally, its total mass is so large that it controls all aspects of the universe including its final fate.

At each renewal point in time, that is, when the energy embodied in the universe returns to its pure energy state after its maximum contraction, the fabric of em-space is recreated before the creation of the baryonic matter universe.

2.3 Infancy of Em-Space: A Very Special Period

In Ref. 3, p. 32, Narlikar notes:

> Gravitation is permanent: it cannot be switched off at will. This ever-present nature of gravitation plays the key role in Einstein's general theory of relativity. Einstein argued that because of its permanence, gravitation must be related to some intrinsic feature of space and time. And, with a master stroke of genius, he identified this feature as the

geometry of space and time. He suggested that any effects we ascribe to gravitation actually arise because the geometry of space and time is "unusual."

Yes, gravity is a permanent feature of the present-day universe and cannot be switched off at will; however, that does not mean it was always like that. This theory proposes that gravity was nonexistent at the time of singularity and during the birth of em-space. Furthermore, it was not a feature of the infant universe for quite some time.

With the absence of gravity at the outset, em-space, while having an extremely high energy–mass density in its pure energy state, was not subjected to any inward gravitational pull and hence could readily expand or radiate with an expansion speed equal to that of light.

Probably only after the Planck time, the three remaining forces of nature, namely, the electromagnetic, the strong, and the weak forces, emerged in the form of a unified force as assumed to be the case in the big bang theory. These three forces then separated from each other, probably in the manner explained by the standard big bang theory.[2] For quite some time only these three forces reigned in the universe. As em-space expanded and cooled, it provided the necessary environment for the formation of the basic ingredients that make up the matter universe.

Although the fabric of em-space is transparent to matter and light now, it is most likely that this was not the case during em-space's very early youth (see also Sec. 8.6). Early in its life, as em-space was expanding, its mass density decreased, while its transparency increased. While em-space was opaque to matter, it would be expected to impart its expansion speed to the matter universe so that both were expanding simultaneously at the speed of light. As gravity developed with the expanding em-space, it started to have an influence on the expanding matter universe in that, as gravity strengthened, it began to slow the expansion of the matter universe and influence the formation of galaxies.

2.4 Slowly Increasing Gravity

In my theory the potential for gravitation is embodied in the expanding fabric of em-space. As em-space expanded, its fabric stretched in every direction. As a result, gravity built up within the fabric of em-space, regardless of whether a matter universe existed or not. Gravity is the observed representation of the potential energy stored in the expanding fabric of em-space and is shown to be related to the mass of em-space and to the stiffness of its fabric (see Secs. 7 and 8). From the beginning of em-space to its current age, gravity [represented by the universal gravitational constant (UGC) G] has slowly and continuously built up to its present strength. The value of G will continue to increase for a long time to come. The measurements of the annual rate of change of the UGC verify my view that G is increasing in time rather than decreasing.[20,22,23] However, this increase in the value of G is very small and is estimated to be about 3.345×10^{-18} dyn $\cdot$ cm$^2 \cdot$ g^{-2} per year (see Sec. 8.5).

In this cosmological model a slowly but continuously increasing gravity (see Sec. 8.5) controls the large- as well as small-scale infrastructure of the matter universe. Nothing in the universe would escape the effect of this slow but continuous increase in G. It should be noted that the effect of a slowly increasing gravity on the formation of the matter universe would be totally different from that which would have been caused by a full-strength gravity existing since the beginning up to the present age of the universe. Under the influence of a gradually increasing gravity all matter objects and object systems in the universe would continuously evolve, becoming more compact over time. In addition to its supreme influence in shaping the grand-scale structure of the universe (see Sec. 10), for example, it is also expected that planetary orbits around stars shorten, and large planets orbiting stars (such as Jupiter and Saturn in our solar system) will compact enough over time such that they may ignite to become stars themselves. Having multiple star systems extensively in the Milky Way and in other galaxies may be evidence for this type of astronomical event; the amount of matter required in the formation of young stars would be substantially less than the matter needed to form comparatively older stars.

In the star formation process the older stars would be far greater in size and mass than the younger ones (see Sec. 10); the population of multistar systems (double stars, etc., in galaxies) would be quite extensive in the universe. In such star systems there could be a considerable difference between the ages of the companion stars (in the order of 5 to 6 billion years).

In the case of Earth, its effect would also be very dramatic. Early in Earth's infant years its diameter must have been significantly larger than it is now. During the last 4 billion years, the value of G has increased about 25%. Due to this slow but continuous increase in G, the Earth's body must have compacted considerably, resulting in increased internal pressure and heat. This, in turn, would start volcanic activity and would also cause the Earth's crust to split along weak lines. As the crust of the planet splits, it lets the molten magma out, thus creating the continental land masses on the Earth. As the crust of the Earth gives way to inside pressure by splitting at various places, it would cause the start of major magma currents inside the Earth, which, in turn, would generate the movement of land masses on magma (continental drift). Of course, the movement of land masses on magma turns itself into a permanent kneading machine which works continuously on Earth's material, uplifting the bottom of oceans into new land masses and turning some old land masses back into magma. Thus the whole process results in a dynamic planet that continuously evolves and renews its macro and micro appearance. Additionally, as Earth shrinks in size, it revolves faster around its own axis, thus shortening the day over time. Over the last 4 billion years the length of an Earth day could have been reduced from about 32 hours to the present 24 hours. It is likely that the effects of such an evolution have been stored in some detectable manner in the history of Earth-bound systems. Similar effects would be expected in other Earth-like planets in all planetary systems.

On a smaller scale one would expect, for example, that the size of living species on Earth would shrink in time. The increasing G would eventually hinder the movements of living beings such as the flight of birds. To counter this effect, they

would adapt by being lighter in weight and/or smaller in size. The corollary to this would be that the smaller species would tend to prevail on Earth. The effects of a slowly increasing G are likely to show up in a myriad of ways in life and events taking place on Earth.

2.5 Expected Collapse of Em-Space

Em-space is in its infancy stage at present and is still expanding, but the continuous conversion of kinetic energy into potential energy translates into a "braking effect" that slowly reduces the expansion speed of em-space. Eventually, all the kinetic energy that originally started em-space expanding will be converted to potential energy, thereby signaling the end of expansion and the start of contraction. The contraction will be due to increased gravity. After all the kinetic energy driving em-space to expand to its maximum size has been converted into potential energy in the fabric of em-space, it will then start contracting back to its original birth size under the influence of the built-up tension (stored potential energy) in its fabric. As it collapses, the stored potential energy in the fabric of em-space will gradually convert back into kinetic energy in the form of an increasing contraction speed. As em-space approaches its original birth size at the expense of a weakening gravity, the contraction speed will once again be equal to that of light, and gravity will have weakened into nonexistence.

After reaching its original birth size, that is, the energy singularity, the next half cycle of em-space will start again with everything essentially repeating itself, possibly even in a negative mode, which is to say that the new half cycle may even give birth to an antimatter universe as opposed to a matter universe!

Viewed in this manner, em-space presents itself as a closed energy–mass system regardless of whether or not a matter universe exists in it. The simple pendulum-like motion of em-space, discussed later in more detail (see Sec. 5), makes it cyclic in nature and should therefore repeat itself forever.

3. THE START OFF

Let the pure energy content of the initial singularity be represented by E. It can be assumed that right after $t = 0$ one part of this pure energy, say, E_{ems}, was used to form both the fabric of em-space and the matter universe in it, and the remaining part, say K_{ems}, was used to drive em-space into expansion. Thus the total energy of the singularity may be represented by

$$E = E_{\mathrm{ems}} + K_{\mathrm{ems}}. \tag{1}$$

Having been formed from E_{ems} that was part of the available energy in the initial singularity, em-space would be expected to be in immense kinetics as its high energy–mass density and temperature suggest. The kinetic energy of em-space may be written as

$$K_{\mathrm{ems}} = M_{\mathrm{ems}}v^2/2, \tag{2}$$

where v is the expansion speed of em-space, and M_{ems} is the mass of em-space and the embedded matter universe. In this expression, by letting $v = l/t$ and rearranging it, we get

$$l^2 = 2K_{\mathrm{ems}}t^2/M_{\mathrm{ems}}. \tag{3}$$

Normally, l would be the distance traveled by a body moving with the speed v over a time duration t. In the case of em-space, which had nowhere to move at birth or any other time but expand from a size of almost zero, l would represent the size of its radius achieved by expansion with the speed v over its age. Thus in Eq. (3) l is the radius of em-space, and t is its age after $t = 0$ in seconds. It is clear that em-space starting with a kinetic energy and the size of almost zero at birth had no option but to expand.

From Einstein's energy–mass relation $E = mc^2$ we have $M_{\mathrm{ems}} = E_{\mathrm{ems}}/c^2$, and by using it in Eq. (3) we get

$$l^2 = 2K_{\mathrm{ems}}t^2c^2/E_{\mathrm{ems}}. \tag{4}$$

Initially, since there was no gravity (second notion of this theory), the initial pure energy singularity could radiate (or expand) with the speed of light in all directions. This may be shown to be the case if the value of E_{ems} was such that when used in Eq. (4) it would reduce the expression to $l = ct$. This can be achieved if $E_{\mathrm{ems}} = 2K_{\mathrm{ems}}$. Thus, by substituting this value of E_{ems} in Eq. (4) and taking the square root of both sides, we obtain

$$l = ct, \tag{5}$$

where c is the speed of light, 3×10^{10} cm/s.

It is seen from Eq. (5) that right after its birth the size of em-space started to expand by having its radius enlarge with the speed of light. So v_0, the initial speed of expansion of em-space, was the same as c. As the universe ages, this initial speed would slow down to values less than c. Values of expansion speed with the age of em-space are given in Table I in Sec. 8. Expansion of the initial pure energy singularity with the speed of light provided the needed inflation for the hot fire ball of energy to cool down so that the rest of the processes of universe formation could take place.

Equation (5) shows that em-space is expanding, and expansion is an inherent feature of it. However, it does not need an explosion for the expansion to take place. The observed presence of redshifts in the light from distant galaxies is the verified indication of this natural expansion. Equation (5) also relates the equivalency of time and the spatial dimensions of em-space to each other with the intermediary function of the speed of light.

Using this expression, one can calculate the radius of em-space during its early age; for example, at Planck time we get $l = 1.62 \times 10^{-33}$ cm (Ref. 3, p. 214; Ref. 10, p. 49).

By multiplying both sides of Eq. (3) with 4π, we get the following expression:

$$4\pi l^2 = 4\pi(2K_{\mathrm{ems}}t^2)/M_{\mathrm{ems}}. \tag{6}$$

The left-hand side of this expression represents the surface area

of a spherical structure, that is, in this case it is the surface of the expanding em-space, and the right-hand side shows the equivalence of that surface area in terms of kinetic energy, age, and mass of em-space.

Similarly, using Eq. (3), one finds the radius and the volume of em-space also being functions of the kinetic energy, age, and mass of em-space. This finding supports the first notion of this theory that em-space is associated with energy and mass. In addition, the radius and the volume of em-space are also increasing with its age.

Using Eqs. (3) and (5), we have the following summary expressions for the radius, surface, and volume of em-space, as functions of c and t shown in Eqs. (7a), (8a), and (9a) below, or in terms of the mass and the kinetic energy associated with em-space and its age shown in Eqs. (7b), (8b), and (9b), until the expansion speed becomes less than the speed of light:

$$R_{\text{em-space}} = R_{\text{ems}} = l = ct; \tag{7a}$$

$$R_{\text{em-space}} = \left[\left[\frac{2K_{\text{ems}}}{M_{\text{ems}}}\right]^{1/2}\right] t; \tag{7b}$$

$$S_{\text{em-space}} = S_{\text{ems}} = 4\pi l^2 = 4\pi c^2 t^2; \tag{8a}$$

$$S_{\text{em-space}} = \frac{4\pi(2K_{\text{ems}}t^2)}{M_{\text{ems}}}; \tag{8b}$$

$$V_{\text{em-space}} = V_{\text{ems}} = \frac{4\pi l^3}{3} = \frac{4\pi c^3 t^3}{3}; \tag{9a}$$

$$V_{\text{em-space}} = \frac{4\pi t^3}{3}\left[\left[\frac{2K_{\text{ems}}}{M_{\text{ems}}}\right]^{1/2}\right]^3. \tag{9b}$$

It is seen from these expressions that the radius, surface, and volume of em-space have been expanding since birth, and they are also related to the mass of em-space, including that of the matter universe and the kinetic energy that drives this system into expansion.

From the above scenario the division of the energy available in the initial singularity among the mass of em-space and its kinetic energy in a ratio such that $E_{\text{ems}} = 2K_{\text{ems}}$ seems to be the most natural relation to follow. With this relation we have $l = ct$, which defines the start-off speed of an expanding universe.

4. COMPARISON WITH OTHER COSMOLOGICAL MODELS

4.1 The Big Bang Theory and Em-Space Cosmology

Figure 1(a) is a representative graph of the radius $l(t)$ of em-space, as per "Em-space and Renewal-at-π Cosmology" (hereinafter referred to as em-space cosmology). The horizontal line is the time axis representing the age of the universe up to its present age of about 20 billion years. In it, the beginning of the universe ($t = 0$) is at point O, the present radius of the universe is the ordinate PB, and the present position of the universe on the expansion curve corresponds to point P.

Figure 1(b) is a similar graph showing the radius $l(t)$ of the universe as a function of time in the Einstein–de Sitter model (Ref. 3, p. 118), a special case of the Friedmann models (Ref. 3, p. 116), which are essentially the models for the big bang theory. In this graph, point P indicates the position of the universe at the present age, while ordinate PB represents the present radius of the universe. The beginning of the universe is at point O. The point C, which corresponds to point O in Fig. 1(a), is the point at which the tangent to the curve $l(t)$ at point P intersects the time axis. The time duration OB is the present age of the universe and is two-thirds of the intercept BC, which is the inverse of the Hubble constant H_0 (Ref. 3, p. 118).

These two models differ substantially. First, the age of the universe in the big bang theory is one-third shorter than it is in em-space cosmology, that is; if the age is say 12 billion years in the big bang theory, it would be 18 billion years in em-space cosmology. Second, whereas em-space cosmology has a gradual expansion, the big bang model requires a very large inflation at the origin, such as by a factor of about 10^{50} or more during the period between 10^{-35} s and 10^{-32} s after $t = 0$ (Ref. 2, p. 352; Ref. 10). The inflation feature is formulated to overcome some major problems such as the horizon problem and the flatness of the universe (Ref. 2, p. 352; Ref. 10) associated with the big bang theory.

Third, while em-space cosmology has no gravity at the beginning and for quite some time after, the big bang theory, by assuming a permanent presence of gravity in the universe, states that gravity separated from the remaining three forces of nature at about 10^{-40} s after $t = 0$ and has continued with a constant strength since then. This sudden emergence of gravity from the energy singularity in the big bang theory would surely have prevented the expansion of the universe, while the lack of gravity at the outset of the universe in em-space cosmology would have readily allowed expansion to take place.

As represented by the area under the curves in Figs. 1(a) and 1(b), respectively, the size of the visible universe in em-space cosmology is much larger than that in the big bang theory, in which the life of the universe presented by the lined area in Fig. 1(b) is not part of the big bang. Similarly, in the big bang, while the horizon distance is c times $\overline{\text{OB}}$, where c is the speed of light, it is c times $\overline{\text{CB}}$ in em-space cosmology. Because of this difference in age, the horizon distance in the big bang is one-third shorter than the horizon distance in em-space cosmology. Hence, while the big bang theory would have the horizon problem, em-space cosmology would not. In other words, in the big bang theory the horizon problem persists because the calculated horizon distance is smaller than the observed universe. On the other hand, if the real universe is represented by the proposed em-space cosmology, the horizon distance and the observed universe are the same and hence there would be no horizon problem.

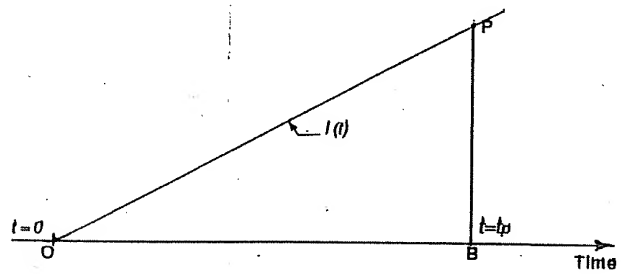

Figure 1(a). A representative diagram showing the radius of the universe in em-space and renewal-at-π cosmology.

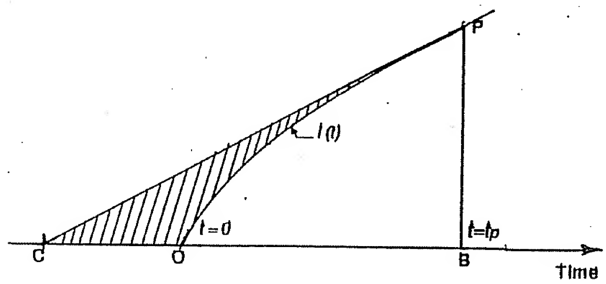

Figure 1(b). A representative diagram showing the radius of the universe in the Einstein–de Sitter model.

The presence of a permanent and strong gravity during the early formation years of the universe is a handicap for the big bang model in trying to explain the large-scale structural appearance of the universe. On the other hand, the lack of gravity at birth followed by a gradually strengthening gravity in em-space cosmology is an advantage not only for the expansion of the universe, but also for the fragmentation of the initial homogeneous matter cloud into "matter islands" that later would evolve into superclusters of galaxies and other observed objects. Fragmentation of the initial homogeneous matter cloud is explained in Sec. 10.

In em-space cosmology the total energy making up all aspects of the system is always conserved. Thus the laws of conservation of energy and matter hold true at all times.

Em-space cosmology is a cyclical system that renews itself at the end of each contraction period.

In em-space cosmology the expansion rate of the universe is not constant; it varies in time, starting at the speed of light at the beginning and becoming zero when the system reaches its maximum size.

Em-space cosmology resembles the big bang cosmology only in the sense that both are expanding at the present age of the universe, and the process of matter creation was probably the same or similar in both systems.

4.2 The Quasi-Steady-State Cosmological Model and Em-Space Cosmology

QSSC is an ongoing system that occasionally replenishes itself with "little big bangs" that take place at "creation centers" in a universe that has no beginning or end. Certain conditions must be met in the creation centers in order to have these "little big bangs" take place. Little big bangs can follow a cyclic pattern if the required conditions are maintained. In QSSC, gravity is a constant natural force associated with the matter in the universe, and it needs to be maintained constant in an expanding universe by the replenishment of matter by means of "little big bangs." In em-space cosmology gravity is associated with the fabric of em-space itself, and it increases with time until em-space reaches its maximum size; then it starts decreasing to finally attain a value of zero at the maximum contraction. The QSSC model and em-space cosmology differ radically from each other in system concept.

4.3 Steady-State Theory Without Expansion and Without Continuous Creation of Matter

In this model of cosmology the universe is nonexpanding, and the redshifts in the frequency of light from distant galaxies are due to the "tired light" concept, while em-space cosmology is a model of an expanding universe, and the redshifts in the light are related to the expansion velocity of the em-space and the receding velocities of the galaxies from the observation point in em-space. Thus in a way, it is due to the Doppler effect.

4.4 The Plasma Universe and Em-Space Cosmology

In the plasma universe concept the universe is filled with "plasma," which is ionized matter. Plasma is the dominant element making up most of the mass of the universe. A plasma universe needs the presence of strong electromagnetism together with gravity all throughout space so that both together can cause the plasma to be pinched into filaments that can then be condensed into other states of matter. The plasma universe model does not require the big bang for the production of light elements and assumes that the light elements and the microwave background radiation were all generated by massive stars in the early stages of galaxy formation.

In comparison with the plasma universe, in em-space cosmology the mass of em-space is the dominant mass. The fabric of em-space is not like matter in any matter state. It is a unique and special creation of nature, and we are not able to physically determine the nature of its structure at present. Em-space cosmology also does not require a big bang explosion.

4.5 The Large-Numbers Hypothesis and Em-Space Cosmology

In Dirac's cosmological model a time-varying gravity in an expanding universe is assumed. The universal gravitational constant G decreases in time and becomes weaker and weaker forever. In Dirac's universe matter is created uniformly throughout the whole of space. Matter is created either in intergalactic space or in places where matter already exists.

In em-space cosmology gravity becomes stronger as em-space continues to expand to its maximum size and weaker after em-space starts contracting.

For example, in Dirac's cosmology the periods of the motion of planets around the Sun are necessarily increasing in time because of an ever-decreasing gravitational constant, while in

em-space cosmology the planetary periods would be getting smaller in time during the expansion phase of the universe.

5. THE STRETCHED SPRING MODEL OF EM-SPACE

5.1 Em-Space, the Longest Wavelength Pendulum

Let the circle shown in Fig. 2 represent a cross section of the spherically expanding em-space at an age of t s with respect to the initial starting point in time, say O. In addition, let point A be any one of the infinite number of points along the periphery of the shown circle. As em-space expands, point A, whose starting location was t s ago at point O, will be displaced farther away from O. Let the displacement of point A be represented by x.

Let us consider the fabric of em-space along the radial from point O to A to be like a slowly stretched spring into which a restoring force F is built up gradually as em-space expands. This stretched spring model is assumed to be working along all radial directions of the spherically expanding em-space with respect to point O at its center (or the transition point, TP). The force F would always act against the expansion of em-space and will try to restore the position of point A to O. The restoring force is determined by Hooke's law, which is equal to $-kx$, where x is the displacement of point A with respect to point O, and k is a constant representing the stiffness of the fabric of em-space. Using Hooke's law, we have the expression for the restoring force as (Ref. 24, pp. 118, 284; Ref. 25, p. 315)

$$F = md^2x/dt^2 = -kx, \tag{10a}$$

$$d^2x/dt^2 = -kx/m, \tag{10b}$$

$$d^2x/dt^2 + kx/m = 0, \tag{10c}$$

or

$$d^2x/dt^2 + p^2x = 0, \tag{10d}$$

where m in the above equations represents M_{ems}, the mass of em-space indicated earlier in Sec. 3, and

$$p^2 = k/m, \tag{11a}$$

or

$$p = (k/m)^{1/2}. \tag{11b}$$

Equation (10c) [or (10d)] is the differential equation for simple harmonic motion. Its solution can be in the form of (Ref. 25, pp. 314, 324)

$$x = C_1 \sin(pt + \beta), \tag{12a}$$

$$x = C_1 \cos(pt + \beta), \tag{12b}$$

$$x = C_1 \sin pt + C_2 \cos pt. \tag{12c}$$

Since x is initially zero, we use the form given by Eq. (12a).

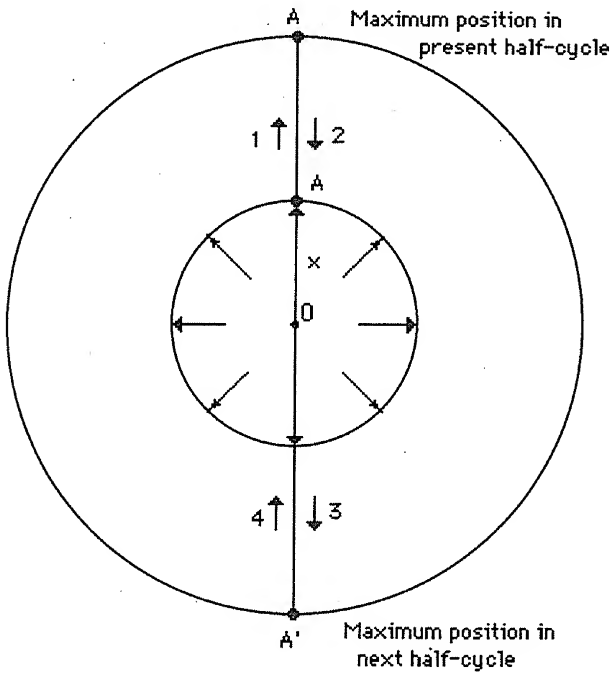

Figure 2. Displacement of a point along the expanding periphery of em-space.

Hence for our purposes we have

$$x = C_1 \sin(pt + \beta), \tag{13}$$

where β is a phase constant whose value needs to be determined. Similarly, p is a constant which involves the total mass of em-space inclusive of the mass of the matter universe and the stiffness of the fabric of em-space. Equation (13) gives the displacement of point A along the periphery of expanding em-space as a function of time. In this expression, when $t = 0$, x is also zero. Thus the phase constant angle β must be zero. Hence x becomes $x = C_1 \sin pt$.

This expression indicates that the displacement of point A with respect to O is sinusoidal. It attains a maximum value x_{max} at time t_{max} after which it starts contracting towards point O. Point A, after returning to point O, continues on its journey to a new position in the next expansion cycle of em-space. If we follow the path of point A in accordance with its simple harmonic motion expression, we have a picture as shown in Fig. 3.

The first derivative of x with respect to time t, which is the expansion speed υ of em-space, is given below as

$$dx/dt = \vartheta = C_1 p \cos pt. \tag{14}$$

When $t = 0$, $\cos pt$ is 1, and thus ϑ becomes $C_1 p$. But the maximum value of ϑ is the start-off value ϑ_0 of the expanding em-space, which is equal to the speed of light c, as given in

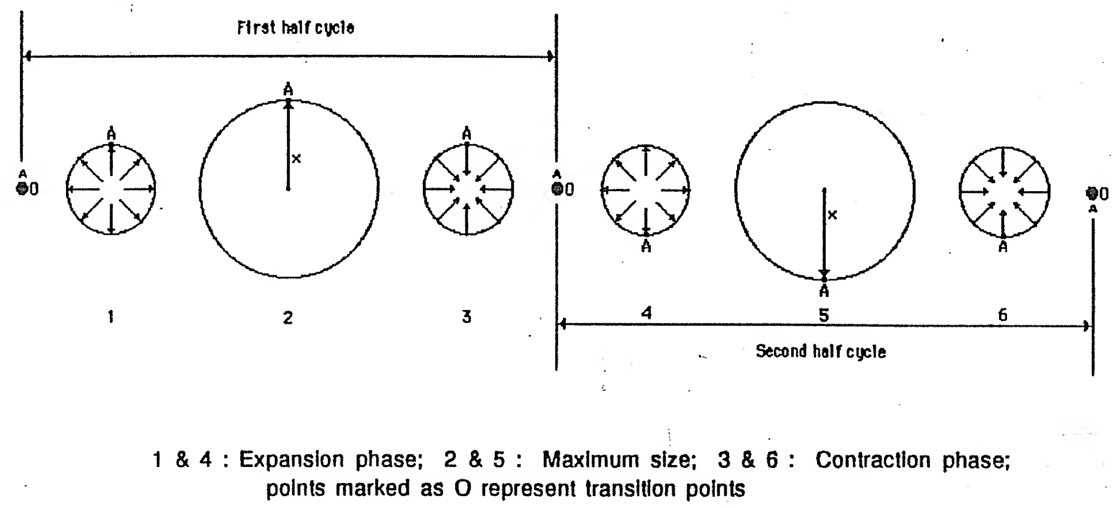

Figure 3. Relative positions of a point A along the periphery of expanding em-space in two consecutive half cycles of em-space.

Eq. (7). Hence $C_1 = c/p$. On the other hand, the maximum value of x is reached when ϑ becomes zero, which takes place when $pt = \pi/2$. Thus we have the following relations. For all values of t:

$$x = (c/p)\sin pt, \tag{15}$$

$$\vartheta = c\cos pt; \tag{16}$$

when $pt = \pi/2$:

$$x_{\max} = c/p, \tag{17a}$$

$$\vartheta = 0; \tag{17b}$$

when $pt = 0$ or $pt = \pi$:

$$x = 0 \text{ and} \tag{18a}$$

$$\vartheta = \vartheta_0 = c. \tag{18b}$$

The second derivative of x given by Eq. (15) with respect to time t gives a deceleration factor in the expansion of em-space. This deceleration is due to the mass and stiffness of the fabric of em-space. As em-space expands, a reactive force builds up, pulling the fabric of em-space towards the point O. The deceleration is given as

$$d^2x/dt^2 = \delta = -cp\sin pt, \tag{19}$$

or

$$\delta = -p^2x. \tag{20}$$

When x is $x_{\max}$, that is, the maximum value of displacement of point A, t equals $t_{\max}$, the age at which the expansion of em-space stops or when the expansion speed of em-space becomes zero. This happens when $pt_{\max} = \pi/2$ at which time x becomes

$$x_{\max} = 2ct_{\max}/\pi, \tag{21}$$

where t is in seconds, p is in inverse seconds, that is, s^{-1}, and pt is in radians:

$$t_{\max} = \pi/2p, \tag{22a}$$

or

$$p = (k/m)^{1/2} = \pi/2t_{\max}. \tag{22b}$$

For the identities of k and m in terms of age of em-space (time), we have

$$k = m\pi^2/4t^2_{\max}, \tag{23a}$$

or

$$m = 4kt^2_{\max}/\pi^2, \tag{23b}$$

where the stiffness k of em-space is in grams per square seconds. Similarly, we have for the maximum value of deceleration

$$\delta_{\max} = -p^2x_{\max}. \tag{24}$$

We must also show the present values of x, ϑ, and δ, that is,

x_p, ϑ_p, and δ_p at the present age t_p of the universe as

$$x_p = c \sin pt_p/p, \tag{25}$$

$$\vartheta_p = c \cos pt_p, \tag{26}$$

$$\delta_p = -cp \sin pt_p. \tag{27}$$

5.2 Estimation of Values of p and t_p

In order to evaluate these identities, we must estimate a value for p and t_p. The first approximation follows the question of whether the present age of the universe is 10 or 20 billion years. In both cases t_p would be in the order of 10^{17} s. Hence the value of p, in inverse seconds, must be less than $(\pi/2) \times 10^{-17}$, since a value of $p = (\pi/2) \times 10^{-17}\ \mathrm{s}^{-1}$ in Eq. (22a) would yield a value of 10^{17} s for t_{max}. This would make the t_{max} the same as the t_p, which could not be, because the universe is not at its maximum expansion yet. So the value of p must be several orders of magnitude smaller than $10^{-17}\ \mathrm{s}^{-1}$. I have assumed a value of $10^{-19}\ \mathrm{s}^{-1}$ for p.

On the other hand, a value of, say, $(\pi/2) \times 10^{17}$ s for t_p would yield a present age of 4.9707 billion years (about the age of our Sun), which would be too young an age for the universe. Hence t_p must be larger than this value.

Considering that the formation of galaxies and also some star clusters in the galaxies, such as the globular clusters in the Milky Way Galaxy, requires time durations considerably longer than 5 to 10 billion years, and also the fact that some quasars have redshifts in excess of $z = 4.0$ (Ref. 3, p. 374; Ref. 26), meaning that light from such objects may have been traveling for more than 10 billion years to reach Earth, I have assumed a value of $2\pi \times 10^{17}$ s for the present age of the universe. The value of $2\pi \times 10^{17}$ s for t_p corresponds to 19.92 billion years, which seems to be in the right age range as indicated by the second limit of the Hubble constant. Although having a value of $2\pi \times 10^{17}$ s for the present age of the universe strikes one as a curious coincidence, I have chosen to happily live with it until a more credible figure is available.

In addition, using Eq. (26) this value of t_p would yield a value of 2.994×10^{10} cm/s for the present expansion speed of em-space, ϑ_p, with respect to point O. This expansion speed of em-space is the same as the recession speeds of galaxies at 1 rad from an observation point OP at a distance of x_p cm from point O. This, in turn, gives a recession speed of 49 km/s at 1 Mpc as given in detail below.

At this point, we should also note from the expression for x, the displacement of point A, that the absolute value of x is nothing but the radius of the expanding em-space. Hence for the remainder of this paper we will represent the radius of em-space with

$$l = x = (c \sin pt)/p \tag{28a}$$

for the first half cycle, and for the second half cycle it will be

$$l = |x| = |(c \sin pt)/p| \tag{28b}$$

5.3 Recession Speeds of Objects at 1 Mpc

In a circle having the present radius l_p of em-space, the length of the arc segment across an angle of $\theta = 1$ rad, or 57.3°, is the same as the length of the radius l_p. Using the $t_p \times 10^{17}$ s in Eq. (28a), we get $l_p = 1.8837 \times 10^{28}$ cm. In this length there are η numbers of megaparsecs (which is the present size of em-space in terms of megaparsec) whose value is given below:

$$\eta = (1.8837 \times 10^{28})/(3.0856 \times 10^{24}) \tag{29a}$$

$$= 6105\ \mathrm{Mpc} \tag{29b}$$

(the length of 1 Mpc is 3.0856×10^{24} cm). One megaparsec across such an arc would correspond to an angle of ζ defined as

$$\zeta = (1\ \mathrm{rad})/6105, \text{ which gives an angle of}$$

$$= 9.386 \times 10^{-3}\ \mathrm{degrees/Mpc}. \tag{30}$$

The recession speed ϑ_{rec} of galaxies at 1 Mpc would be

$$\vartheta_{rec} = \frac{\vartheta_p}{6105} = \frac{2.994 \times 10^{10}\ \mathrm{cm/s}}{6105} \tag{31a}$$

$$= 4.9043 \times 10^6\ \mathrm{cm/s} \text{ or } 49.043\ \mathrm{km/s}, \tag{31b}$$

which is one of the boundary figures of the Hubble constant.

On the other hand, if we use the value, say, $t_p = \pi \times 10^{17}$ s, this would yield an age of 9.962 billion years as the present age of the universe, that is, a younger universe. For this age of em-space we would have $l_p = 9.4232 \times 10^{27}$ cm; $\vartheta_p = 2.9985 \times 10^{10}$ cm/s, that is, a faster expanding universe; $\eta = 3054$ Mpc (present size of em-space); $\zeta = 1.8763 \times 10^{-2}$ degree/Mpc and a recession speed of $\vartheta_{rec} = 98.185$ km/s at 1 Mpc. This value of ϑ_{rec} agrees with the second limit of the Hubble constant.

Of these two alternatives I believe that the older universe at the age of 19.92 billion years is much more likely, since it would allow gravity and the matter universe in em-space to develop to their present states and the redshifts of light from quasars to be in the values as presently observed. Therefore, I have chosen 19.92 billion years as the correct present age of em-space (universe).

5.4 Estimation of the Mass of Em-Space

At this point we return to the identity p in which the mass of em-space and the stiffness of its fabric are hidden. The expression $p^2 = k/m$ yields

$$m = k/p^2, \tag{32}$$

or

$$k = p^2 m \text{ in } \mathrm{g \cdot s^{-2}}. \tag{33a}$$

Here again I have made an educated guess and assigned a

value of 10^{57} g to the initial value of the mass of em-space, m (i.e., $m = M_{ems}$), until a better figure is provided by the scientists working in the field. In view of the present knowledge or lack of it about the density of the universe (Ref. 3, p. 18), this selection of the value of m represents the mass in the fabric of em-space and the matter universe in it. In its turn it gives a value of

$$k = 10^{19}\ \mathrm{g \cdot s^{-2}}. \tag{33b}$$

Again, it is hoped that correct figures will be found for m and k in the future.

In the model presented above the expected maximum age t_{max}, at which the expansion of em-space and the universe would come to a halt, is calculated to be

$$t_{max} = 1.5708 \times 10^{19}\ \mathrm{s}, \tag{34}$$

or about 497 billion years after its birth from a pure energy singularity. This implies a total life span of about a thousand billion years (994 billion years) for a single half cycle of em-space. It seems that we are at the early infant age of a universe that should live for a very long time.

5.5 Expected Maximum Size of Em-Space

Similarly, the maximum size of the radius of em-space corresponding to this age is given by $l_{max} = c/p$, which gives a calculated value of

$$l_{max} = 3 \times 10^{29}\ \mathrm{cm}, \tag{35a}$$

or in megaparsecs we have

$$l_{max} = 97\,225.0\ \mathrm{Mpc}. \tag{35b}$$

In this scenario the present value δ_p and the expected maximum value δ_{max} of the deceleration that would eventually stop the expansion of em-space and the universe, respectively, are $\delta_p = -pc \sin pt_p$ and $\delta_{max} = -pc$. In numbers, their calculated values are

$$\delta_p = 1.8837 \times 10^{-10}\ \mathrm{cm \cdot s^{-2}}, \tag{36a}$$

$$\delta_{max} = -3 \times 10^{-9}\ \mathrm{cm \cdot s^{-2}}. \tag{36b}$$

Using this model, the displacement x of point A and the expansion speed v of em-space as functions of time are represented in Figs. 4 and 5, respectively. Similarly, the force F working to restore the expansion of em-space to its beginning point O is shown in Fig. 6. Representations are shown for two half cycles after which one full cycle of the harmonic expansion/contraction motion of em-space is completed. The model presented here representing the present and the future life cycles of em-space indicates that em-space, with its embedded matter universe, started in a simple harmonic motion in the past and has renewed itself many times since that supernatural start and will continue to repeat itself.

Figure 7 shows the radius of the expanding em-space during the present half cycle of its expected life.

5.6 Interpretation of the Figures

From Figs. 3 to 7 the following features of em-space are deduced:

(1) Our universe seems to be in a harmonic motion like a giant pendulum. Its calculated period is about 2000 billion years, where em-space and the embedded matter universe renew themselves twice with the duration of each half cycle, taking about 1000 billion years. In each half cycle em-space expands to a maximum size and then contracts to a size of almost zero, if not zero. In each half cycle em-space begins its long journey of expansion at the speed of light. The expansion is spherical and in all directions.

(2) The expansion speed of em-space becomes zero at the age $(\pi/2) \times 10^{19}$ s (497 billion years) from the beginning. At this age all the initial kinetic energy causing the expansion will have been converted to potential energy, and the radius of em-space will have reached its maximum value. Similarly, gravity would also have reached its maximum value. From this age onwards the size of em-space will contract.

(3) Under the influence of the potential energy stored in the stretched fabric of em-space (hence an associated deceleration), the contraction will begin with a speed of zero at the age of $(\pi/2) \times 10^{19}$ s and gradually increase until it once again equals the speed of light at the age of 997 billion years. The universal gravitational constant will also be decreasing during the contraction. The gravity will diminish to negligible levels and eventually will become zero when $t = \pi \times 10^{19}$ s (994 billion years). The half cycle is complete when the age of em-space reaches $\pi \times 10^{19}$ s at which time em-space and the embedded matter universe will have shrunk back to a momentary singularity of pure energy. The size having been reduced to almost zero, the energy–mass density will again reach levels probably greater than 10^{155} g/cm^3, and the temperature will rise to billions of degrees Kelvin.

(4) At this point in its life cycle, em-space will reach a transition point (TP) [the point that I have indicated as point O up to now in Figs. 1(a), 2, and 3] at the age of $\pi \times 10^{19}$ s or multiples of it in other cycles, where it does not stop or disappear into nothingness, but instead starts a new half cycle.

(5) Probably after passing the Planck time but before the TP, the positive and negative charges associated with the matter universe will have neutralized, and the remaining three forces of nature will have disappeared. In this state a totally neutral pure-energy singularity is ready to renew itself. Thus it will cross the TP on its maximum kinetic energy and immediately start a new half cycle.

(6) In this scenario time appears to be an ongoing entity running forever and separate from em-space but closely correlated to it. It gives the impression of running in a circle, that is, its beginning is connected to its end, thus making a closed loop.

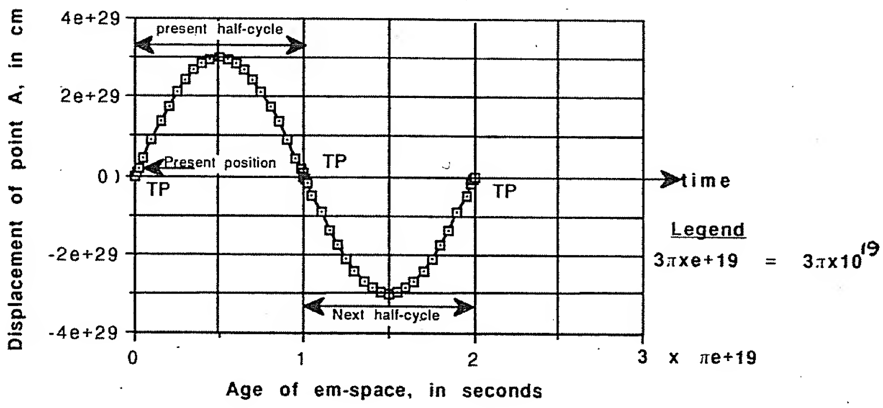

Figure 4. Displacement of a point on the periphery of the expanding em-space.

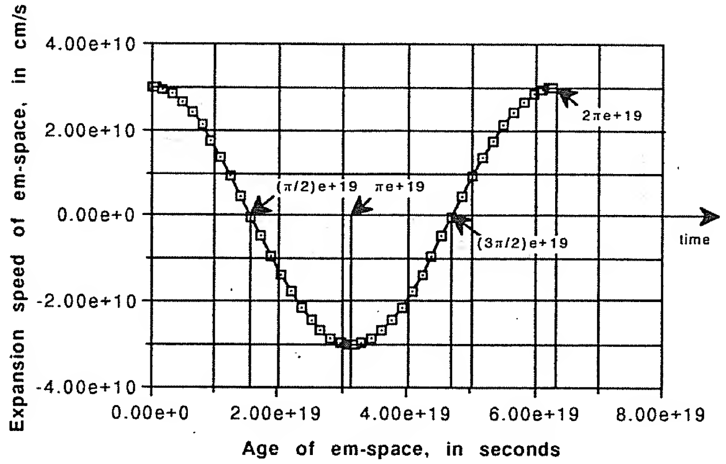

Figure 5. Expansion speed of em-space.

Thus time has no beginning or end. In such a scenario time and em-space run together creating and recreating the universe forever.

(7) New cycles of em-space and the embedded matter universe probably do not start with a "big bang" as big bang cosmology implies, but rather with a smooth transition at the speed of light. Em-space through its contraction phase acquires the greatest momentum as it reaches the TP, and rather than coming to a complete stop there, it goes through a smooth transition which ends one half cycle and starts another. This represents the beginning of a completely new em-space that actually leads to another embedded matter universe. The particles that make up the new matter universe could even be opposite to those of the previous matter universe.

(8) By being an alternating system with possible "matter" and "antimatter" universes in each half cycle, em-space could have an average energy–mass content value of zero throughout its existence. This would make it the largest and most optimized of all optimized systems in nature.

(9) In this model of alternating em-space, during the expansion phase, the expansion velocity of em-space varies between the speed of light and zero. Similarly, during the contraction phase, the contraction speed varies between zero and the speed of light.

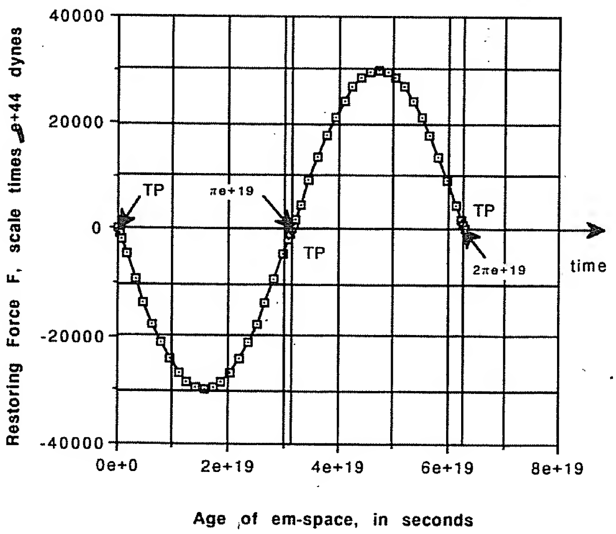

Figure 6. Restoring force acting on the expanding em-space.

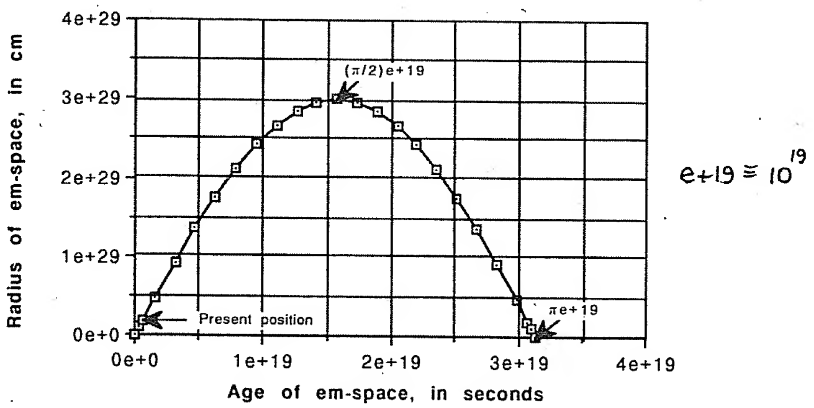

Figure 7. Radius of the expanding em-space.

(10) The present size of the radius of em-space at its present age of $2\pi \times 10^{17}$ s, or 19.92 billion years, is about 1.883×10^{28} cm, or 6105 Mpc. It will reach a maximum size of 3×10^{29} cm, or about 97 000 Mpc, by the age of 497 billion years. At this size the density of em-space will be about 8.8×10^{-33} g/cm^3, or about 4000 times less than its density at its present age.

(11) The time $t = 0$ used throughout this text indicates the beginning of time in our present universe. However, it also represents the end of the previous half cycle, thus representing the TP at π and multiples of π for an infinite number of half cycles that may have been in the past and will be in the future along the time axis.

(12) The figure of π seems to be a very prominent number in the life cycles of em-space. First, the present age of em-space appears to be about $2\pi \times 10^{17}$ s, perhaps due to a lucky coincidence, but nevertheless an arbitrary choice at this time. Second, its maximum size would take place at the age $(\pi/2) \times 10^{19}$ s. And finally, its renewal takes place at the age of $\pi \times 10^{19}$ s or multiples of it. Because of this, I called my theory "Em-space and Renewal-at-π Cosmology."

6. RADIUS, EXPANSION SPEED, VOLUME, AND MASS DENSITY

In view of the above-defined model of em-space and with the use of Eqs. (9), (15), and (16), the radius, expansion speed, and volume of em-space can be calculated at any age. For example, for the present estimated age of $t = 2\pi\ 10^{17}$ s, the radius of em-space is calculated to be $l = 1.883 \times 10^{28}$ cm (6105 Mpc), the expansion speed $v = 99.803\%$ of the speed of light, and its volume $V_{\text{em-space}} = 2.7967 \times 10^{85}$ cm^3. The mass density of em-space is calculated to be $\rho = 3.576 \times 10^{-29}$ g/cm^3. Table I, given in Sec. 8, provides values of these variants at different ages of em-space.

7. POTENTIAL AND KINETIC ENERGIES OF EM-SPACE

As em-space expands, its energy–mass fabric stretches and builds potential energy into it. In time, part of the kinetic energy that set em-space into expansion becomes converted into potential energy. When all the kinetic energy is converted into potential energy, the expansion of em-space will stop.

In Sec. 5.1 we showed em-space as a system in simple harmonic motion. In such a system the stored potential energy is related to the force F that drives the system. Force F, given by Eq. (10a), is also found by taking the derivative of potential energy U with respect to displacement x (Ref. 24, pp. 131, 282), where

$$F = -kx = -dU/dx, \tag{37}$$

or

$$dU = kxdx. \tag{38}$$

Integrating both sides of Eq. (38), we get

$$U = kx^2/2. \tag{39}$$

Since the absolute value of x is also l, the radius of em-space, Eq. (39) may also be written as

$$U = kl^2/2. \tag{40}$$

In Eq. (40), if we use the calculated maximum values of k and the radius of em-space $l_{\max}$ which occurs at the age of $t_{\max}$ at which time the expansion speed of em-space becomes zero, we would have $U_{\max}$, the maximum value of the potential energy,

$$U_{\max} = kl_{\max}^2/2. \tag{41}$$

But $U_{\max}$ and $K_{\max}$ ($K_{\max}$ is the maximum value of the kinetic energy that em-space attained at $t = 0$ at the TP) are equal to each other. $K_{\max}$ is also given by the expression

$$K_{\max} = M_{\text{ems}} v_0^2/2, \tag{42}$$

where v_0 is the start-off expansion speed which is equal to c, speed of light.

We note that the kinetic energy $K_{\max}$ given above in Eq. (42) is the same as K_{ems} given in Eq. (2) and is one-third of the original pure energy of the singularity or one-half of the energy E_{ems} assumed to form the fabric of em-space and the matter universe in it in the initial pure energy singularity.

The potential energy U stored in the fabric of em-space at any age may also be expressed in terms of its mass m, its radius l, and the deceleration δ built into it due to stretching of its fabric by using Eqs. (39) above and (20) of Sec. 5.1. We have

$$U = kx^2/2 \tag{43a}$$

and

$$\delta = -xp^2 \tag{43b}$$

$$\delta = -xk/M_{\text{ems}}, \tag{43c}$$

from which we have for k

$$k = -M_{\text{ems}}\delta/x. \tag{44}$$

By substituting in Eq. (39), we have

$$U = -M_{\text{ems}}\delta x^2/2x = -M_{\text{ems}}\delta x/2. \tag{45}$$

Using $l = x$ for the radius of em-space during the first half cycle, we get the expression for the potential energy in terms of mass, radius, and deceleration:

$$U = -M_{\text{ems}}\delta l/2. \tag{46}$$

Similarly, the potential energy of em-space at its present age would be

$$U_{\text{p}} = -M_{\text{ems}}\delta_{\text{p}} l_{\text{p}}/2. \tag{47}$$

Using the assigned value of M_{ems} and the calculated values of δ_{p} and l_{p}, we find the estimated present value of the potential energy built into em-space to be

$$U_{\text{p}} = 1.773 \times 10^{75}\ \text{g} \cdot \text{cm}^2 \cdot \text{s}^{-2}. \tag{48}$$

Similarly, by using Eq. (40) above and the values of $k = 10^{19}$ g$\cdot$s^{-2} from Eq. (33b) and $l_{\max} = 3 \times 10^{29}$ cm from Eq. (35), we get for the maximum value of the potential energy

$$U_{\max} = 4.5 \times 10^{77}\ \text{g} \cdot \text{cm}^2 \cdot \text{s}^{-2}, \tag{49}$$

$$K_{\max} = 4.5 \times 10^{77}\ \text{g} \cdot \text{cm}^2 \cdot \text{s}^{-2}, \tag{50}$$

$$E = 3 \times K_{\max} = 1.35 \times 10^{78}\ \text{g} \cdot \text{cm}^2 \cdot \text{s}^{-2}. \tag{51}$$

In Eqs. (37) to (51) above, we have the following definitions in cgs:

E: the total energy in the initial singularity, in $g \cdot cm^2 \cdot s^{-2}$;
U: potential energy of em-space at any age, in $g \cdot cm^2 \cdot s^{-2}$;
U_p: potential energy at the present age, in $g \cdot cm^2 \cdot s^{-2}$;
M_{ems}: total mass of em-space and the embedded matter universe, in g;
δ: deceleration of em-space at any age, in $cm^2 \cdot s^{-2}$;
δ_p: present value of deceleration, in $cm^2 \cdot s^{-2}$;
l: radius of em-space at any age, in cm ($l = |x|$, the displacement of a point A on the expanding front shell of em-space);
l_p: present value of radius, in cm.

8. UNIVERSAL GRAVITATIONAL CONSTANT IN EM-SPACE

8.1 An Expression for G

Throughout this theory, we have put forward the idea that there was no gravity at the beginning of the universe and assumed that a "gravitationless" universe persisted for some time during the early life of our universe. It took up to the present age of the universe to build up the universal gravitational constant G to its present measured value. Thus G was a function of the radius of the expanding em-space and consequently of its age.

Let G be linearly proportional to the radius of em-space, that is, $l = |x|$; with the proportionality constant κ we have

$$dG/dl = \kappa, \tag{52}$$

$$G = \kappa l + C. \tag{53}$$

When $l = 0$, $G = 0$ by assumption, and therefore the integration constant $C = 0$. Thus at any age of em-space during its first half cycle we have

$$G = \kappa l, \tag{54a}$$

or

$$G = (\kappa c/p) \sin pt. \tag{54b}$$

At the present age of the universe $l = l_p$ and G has the value of G_p, the present value of the universal gravitational constant (UGC). Hence we have a value for the constant κ,

$$\kappa = G_p/l_p. \tag{55}$$

Using the values of $G_p = 6.6726 \times 10^{-8}$ dyn $\cdot cm^2 \cdot g^{-2}$ and $l_p = 1.8837 \times 10^{28}$ cm, we have

$$\begin{aligned}\kappa &= \frac{6.6726 \times 10^{-8}\ \text{dyn} \cdot \text{cm}^2 \cdot \text{g}^{-2}}{1.8837 \times 10^{28}\ \text{cm}} \\ &= 3.5423 \times 10^{-36}\ \text{dyn} \cdot \text{cm} \cdot \text{g}^{-2},\end{aligned} \tag{56a}$$

or

$$\kappa = 3.5423 \times 10^{-36}\ \text{cm}^2 \cdot \text{g}^{-1} \cdot \text{s}^{-2}. \tag{56b}$$

Thus in terms of κ and l, the UGC G for any size or age of em-space becomes

$$G = 3.5423 \times 10^{-36}\, l, \tag{57a}$$

or by substituting the expression for l, we get

$$G = (\kappa c/p) \sin pt = \kappa' \sin pt, \tag{57b}$$

where

$$\kappa' = \kappa c/p. \tag{57c}$$

In Eq. (57c), using values of κ, c, that is, the speed of light and $p = 10^{-19}\ s^{-1}$, we find $\kappa' = 1.0627 \times 10^{-6}$ dyn $\cdot cm^2 \cdot g^{-2}$. With the expected value of $l_{max} = 3 \times 10^{29}$ cm at the age of $t_{max} = (\pi/2) \times 10^{19}$ s, by using Eq. (57a) or (57b), we find the value of G_{max}:

$$G_{max} = 1.0627 \times 10^{-6}\ \text{dyn} \cdot \text{cm}^2 \cdot \text{g}^{-2}. \tag{58}$$

The ratio of G_{max} to G_p is in the order of about 16.

By using the stiffness of the fabric of em-space k and its mass M_{ems}, in Eq. (54b) we obtain the following expression for G:

$$G = \frac{\kappa c\sqrt{M_{ems}}}{\sqrt{k}} \sin\left[\left(\sqrt{\frac{k}{M_{ems}}}\right) t\right]. \tag{59}$$

Newton's law of universal gravitation between two bodies of matter is given as

$$F = \frac{Gm_1m_2}{r^2}. \tag{60}$$

By using the universal gravitational constant G, defined in Eq. (59), in Eq. (60), we have the following expression for the attractive force due to gravity:

$$F = \frac{\kappa' m_1 m_2}{r^2} \sin pt, \tag{61a}$$

or

$$F = \frac{m_1 m_2 \kappa c}{r^2}\sqrt{\frac{M_{ems}}{k}} \sin\left[\left(\sqrt{\frac{k}{M_{ems}}}\right) t\right], \tag{61b}$$

where m_1 and m_2 are the masses of the two attracting bodies of matter embedded in em-space, and r is the distance between m_1 and m_2.

For example, when the radius of em-space was 1 Mpc, that is, 3.0856×10^{24} cm, which would have taken place when the age of em-space was $t = 1.0285 \times 10^{14}$ s, or about 3.2549 million years from $t = 0$, the value of G had just built up to 1.0930×10^{-11} dyn$\cdot$cm$^2\cdot$g^{-2}. The ratio of G_p to this value of G is 6105. Thus the attractive force between two bodies of 1 g mass each and separated by a distance of 1 cm would be 1.0930×10^{-11} dyn, which is 6105 times less than the value that it would be at the present age of the universe.

8.2 G-Related Deceleration of Em-Space

From Eqs. (19) and (28a) we have the built-up deceleration and the radius of em-space for any age during the first half cycle of em-space as follows:

$$\delta = -cp \sin pt, \tag{62}$$

$$l = (c/p) \sin pt. \tag{63}$$

Dividing Eq. (63) by Eq. (62) we have

$$l/\delta = -1/p^2, \tag{64a}$$

or

$$l/\delta = -M_{\text{ems}}/k. \tag{64b}$$

The negative sign associated with this expression is due to δ, which is caused by the tension that is built up from the stretching of em-space. It indicates a force that is slowing down the expansion of em-space. By rearranging Eq. (64) for δ, we have

$$\delta = -lp^2, \tag{65a}$$

or

$$\delta = -lk/M_{\text{ems}}. \tag{65b}$$

From Eq. (54a) we have $l = G/\kappa$, and substituting for l in these expressions we have

$$\delta = -Gk/\kappa M_{\text{ems}}, \tag{66a}$$

or

$$\delta = -Gp^2/\kappa. \tag{66b}$$

l, δ, and G are all variables in time. By rearranging Eqs. (66a) and (66b) for G, we get

$$G = -\kappa\delta/p^2, \tag{67a}$$

or

$$G = -\kappa\delta M_{\text{ems}}/k. \tag{67b}$$

In these expressions we have G related to the deceleration δ of em-space through the constants κ and p or through κ, M_{ems} and k.

By substituting G as defined in Eqs. (67a) and (67b) in Newton's law of universal gravitation, we have

$$F = -\frac{\kappa\delta M_{\text{ems}} m_1 m_2}{kr^2}. \tag{68a}$$

Again, the negative sign in this expression comes from δ and indicates that the force between masses m_1 and m_2 is "attractive."

From Eq. (46) we have an expression for the potential energy U in terms of the mass, deceleration, and the radius of em-space:

$$U = -\frac{l\delta M_{\text{ems}}}{2}, \tag{68b}$$

or

$$\delta = -\frac{2U}{lM_{\text{ems}}}. \tag{68c}$$

By using this value of δ in Eq. (67b) above, we get the following expression for the universal gravitational constant G in terms of κ, U, k, and l:

$$G = \frac{2\kappa U}{kl}. \tag{68d}$$

8.3 Gravitating "Monopole of Matter" in Em-Space

In Eq. (68a) let us use the symbol A, where A is defined as

$$A = -\frac{\kappa\delta M_{\text{ems}}}{kr^2} = -\frac{G}{r^2}\ \text{cm}\cdot\text{g}^{-1}\cdot\text{s}^{-2}, \tag{69a}$$

or

$$A = -\frac{6.6726 \times 10^{-8}}{r^2}\ \text{cm}\cdot\text{g}^{-1}\cdot\text{s}^{-2}. \tag{69b}$$

In this definition r, in centimeters, is the distance from any selected point to any other point in em-space. A, having dimensions in cm$\cdot$g$^{-1}\cdot$s^{-2}, can be interpreted as a "negative omnidirectional acceleration per unit of mass" at every point of em-space and is directed toward the point itself. A may be viewed as a feature or quality of em-space and is the result of the tension that is built up into the entire stretched fabric of em-space. A fills the entire volume of em-space and has the same value throughout em-space. Since the entity A represents a tension in em-space, it may be referred to as the "volume

tension" of em-space and must be the source of the universal gravity. A must also be the source of the inertia exerted by em-space and the matter universe in it on every matter body.

The strength of A associated with every point of em-space is inversely proportional to the square of the distance away from the point. From Eq. (69a) we find, for example, that at a unit distance of 1 cm away from any point in em-space, the strength of A becomes the negative value of the present value of the universal gravitation constant G. This value of A holds throughout em-space. Even if there was no matter universe in em-space, the fabric of em-space would still have this quality of A. Without this quality of em-space, one would not have a "gravitating object," no matter how massive the object might be. Figure 8 represents an imaginary view of A as associated with every point in em-space.

When a matter body of mass m is placed at a point in em-space, the "volume tension" A surrounding the body interacts with the mass of that body, and, as a result of this interaction, it not only becomes amplified by the mass m of the object, but also the whole process is translated into a field of "negative acceleration" that is directed toward the center of that body from all directions. In terms of A and m, this negative acceleration is given as

$$a = mA = -\frac{\kappa \delta M_{\mathrm{ems}} m}{kr^2} \ \mathrm{cm \cdot s^{-2}}. \tag{70}$$

For a particular body of mass m_1, this negative acceleration is

$$a_1 = m_1 A = -\frac{\kappa \delta M_{\mathrm{ems}} m_1}{kr^2} \ \mathrm{cm \cdot s^{-2}}. \tag{71}$$

a_1, being acceleration in nature, has the dimensions of $\mathrm{cm \cdot s^{-2}}$ and may be viewed as being equivalent to a force field that is directed globally towards the mass m_1. The influence of this force field will extend in all directions from m_1 in a diminishing manner, into em-space, like stretched elastic bands that emanate from a point outwards in all directions, except that in this scenario in em-space, the pull becomes smaller as an inverse function of the square of the distance.

When a second matter body of mass m_2 is placed within this "field of negative acceleration" of a_1, it will be accelerated and put into motion towards mass m_1. The force acting on m_2 will be in accordance with Newton's second law of motion, that is, $F = ma$. Hence the force acting on m_2 due to em-space and the embedded mass m_1 is

$$F_1 = m_2 a_1 = m_2 m_1 A. \tag{72a}$$

Similarly, the second body of mass m_2 will also act in the same manner as mass m_1. Now, mass m_1 being within the "field of negative acceleration" of a_2, where $a_2 = m_2 A$, will be accelerated toward mass m_2. The force acting on m_1 due to em-space and mass m_2 is given as

$$F_2 = m_1 a_2 = m_1 m_2 A. \tag{72b}$$

But the forces F_1 and F_2 defined by Eqs. (72a) and (72b) have the same value. We see that F_1 and F_2 are the same force described by Newton's glorious second law of motion. On the other hand, when we insert the expression for A from Eq. (69), we get Newton's famous law of universal gravitation between objects of the matter universe in em-space, in the following form:

$$F = -\frac{m_1 m_2 \kappa \delta M_{\mathrm{ems}}}{kr^2} = \frac{Gm_1 m_2}{r^2}. \tag{73}$$

From these expressions we find that for matter objects in em-space, Newton's second law of motion and the law of universal gravitation are one and the same. It may be said that the presence of a matter body, of say mass m_1, at any point in em-space interacts and modifies the entity A, a quality of em-space, such that both together (i.e., m_1 and A interacting and working together) may be likened to a "monopole of gravitating matter." Such a "monopole" acts like one pole of a magnet attracting all objects of the matter universe around it. Thus in em-space a pair of monopole-like matter objects will interact with each other in such a manner that while mass m_1 pulls mass m_2, similarly the mass m_2 pulls mass m_1, creating the overall effect of mutual attraction.

Figure 9 shows two objects in em-space and the attractive (gravitational) field between them. Of course, in this scenario the smaller mass will be moving towards the larger mass.

In the above scenario it is seen that the universal gravitational force between objects of the matter universe is a function not only of the mass of objects alone and the distance between them, but also of the constant κ, the deceleration built into the fabric of em-space, the factor k, that is, the stiffness of em-space and the M_{ems}, that is, the total mass of em-space and the embedded matter universe. In other words, universal gravitation is much more so a quality of em-space than a quality of the embedded matter universe.

In the above description of the "monopole of matter," in essence, each "monopole of matter" would act as if it were pulling the whole fabric of em-space and the embedded matter universe towards itself. Of course, in return, the rest of the matter universe and em-space would exert a pull on the "monopole of mass m" which must be the cause of the inertia demonstrated by all matter objects in rest or in uniform motion. In this sense, one could even say that em-space and the embedded matter universe in totality are a "monopole system" attracting everything within itself towards a central point. The center of such a system would be at the point that corresponds to the TP in time where em-space completes one cycle and goes into the next cycle. The geometry of em-space is Euclidean throughout its volume except near dense bodies of matter

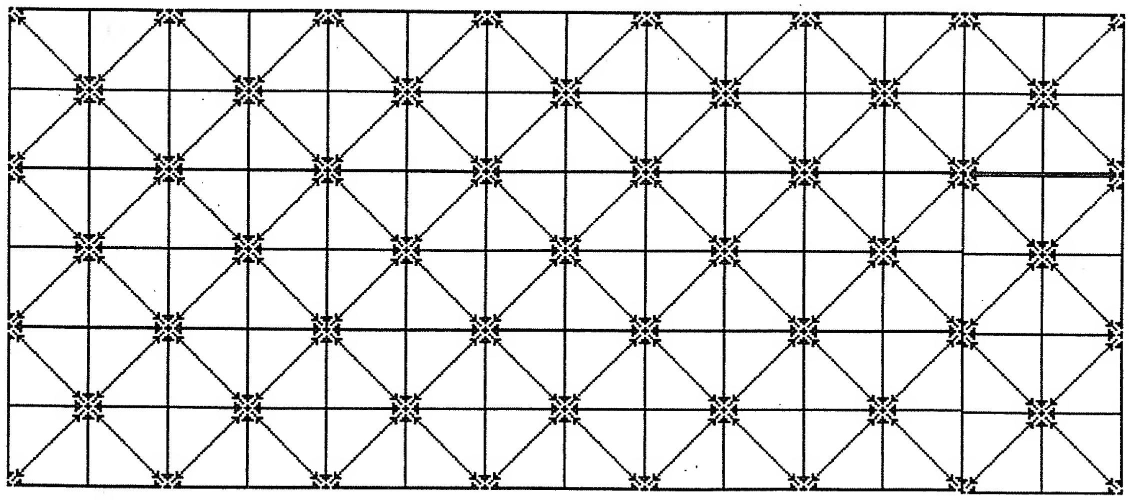

Figure 8. Conceptual two-dimensional representation of the A of em-space.

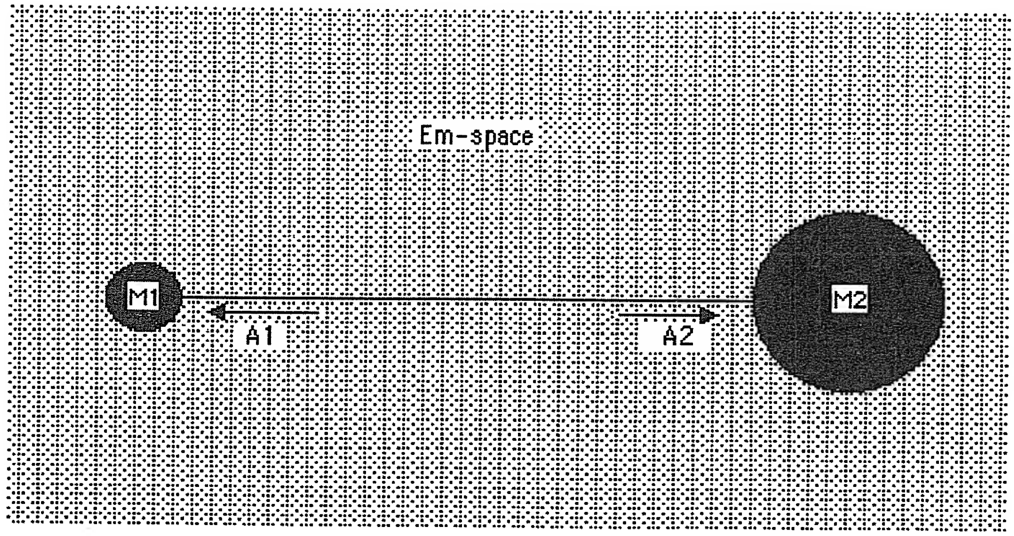

Figure 9. Gravitation between masses m_1 and m_2 in em-space.

universe. Even at its expanding frontal shell it is flat for large distances and its geometry is Euclidean, although em-space is an expanding spherical ball of energy–mass system. Because of its immensely large radius (6105 Mpc at present age), the curvature of the frontal shell would be so shallow that the horizon plane at a point on the surface would be only about 2500 km above the surface of em-space at a distance of 1 pc (about 3.26 light-years) away from the point.

However, the geometry of em-space is modified near objects of matter. If a matter object were suddenly placed anywhere in the Euclidean medium of em-space, the mass of the object interacting with the fabric of em-space would create a concentrated "field of attractive force," or "field of negative acceleration," around itself. In terms of Einstein's general theory of relativity, this might be interpreted as the curved geometry of space-time around the object.

8.4 Discussion

A plot of G versus t, that is, up to the present age of em-space, is given in Fig. 10. Similarly, a plot of G versus the age of em-space over a life cycle is given in Fig. 11. G is

sinusoidal in nature and follows the pattern of the radius of em-space when plotted over two consecutive half cycles of em-space (up to $pt = 2\pi$).

G, like the radius of expanding em-space, rises and falls during each half cycle. G will increase to a value of $G_{max} = 1.0627 \times 10^{-6}$ dyn $\cdot$ cm$^2 \cdot$ g^{-2} at the age of t_{max} of em-space after which it will decrease to a value of zero at the age of $t = \pi/p$ s when em-space reaches the new TP, or the "renewal point."

The next half cycle of em-space is only a renewal of em-space and the embedded matter universe. The fabric of em-space may be considered as having a neutral quality, that is, no positive or negative charges or signs are associated with it. A universe with antimatter particles should be as compatible with em-space as the present matter universe is and should behave in similar ways. Em-space should no more prefer the presence of a matter universe in one half cycle than the presence of an antimatter universe.

In the following half cycle the fabric of em-space, being of the same nature as it is in the present half cycle, would still go through expansion and develop universal gravitation as it has done in the present half cycle.

8.5 Annual Increase in G

Since the universal gravitational constant G is a function of the radius and, hence, of the age of em-space, its value is expected to have an annual increase until t_{max}. By using Eq. (57b), the expected increase in the value of G may be found as follows:

$$G = \kappa' \sin pt, \tag{74}$$

$$G + \Delta G = \kappa' \sin [p(t + \Delta t)], \tag{75a}$$

$$G + \Delta G = \kappa' (\sin pt \cos p\Delta t + \cos pt \sin p\Delta t), \tag{75b}$$

where, because Δt is one year and is very small, $\cos p\Delta t = 1$ and $\sin p\Delta t = p\Delta t$, this expression can be further reduced to

$$G + \Delta G = \kappa' (\sin pt + \cos pt \times p\Delta t). \tag{75c}$$

Deducting expression (74) from (75c), we obtain the expected increase in G:

$$\Delta G = \kappa'(p\Delta t) \cos pt. \tag{76}$$

Using the present age of em-space for t, that is, $t_p = 2\pi \times 10^{17}$ s and $\Delta t = 3.1536 \times 10^7$ s for one year, and $\kappa' = 1.0627 \times 10^{-6}$ dyn $\cdot$ cm$^2 \cdot$ g^{-2}, we get for ΔG,

$$\Delta G = 3.3447 \times 10^{-18} \text{ dyn} \cdot \text{cm}^2 \cdot \text{g}^{-2} \text{ per year.} \tag{77}$$

This value of ΔG is so small in comparison with the value of G that its influence on matter objects would not be easy to detect over short periods of time. Thus in man's lifetime and for all practical purposes, G would be viewed as constant. However, its cumulative effect not only shapes the structure of the universe, but also the structure of every matter object in the universe. The ratio of this change in G to the present value of G_p gives

$$\Delta G/G_p = 5.0126 \times 10^{-11} \text{ per year,} \tag{78}$$

which seems to be, with the exception of the sign, quite well placed in the reported range of results measured by Van Flandern,[22] Reasenberg and Shapiro,[23] and Muller.[27] For example, using the timings of occultations of stars by the Moon, Van Flandern (Ref. 22, p. 26) made the first observational determination of the rate of change of the universal gravitational constant G to have the value $\dot{G}/G = (-5.8 \pm 3.1) \times 10^{-11}$ per year. Reasenberg and Shapiro give the average value of their measurements as $\dot{G}/G = (-6.3 \pm 3.3) \times 10^{-11}$ per year. Muller finds a value of $\dot{G}/G = (-6.9 \pm 3) \times 10^{-11}$ per year (Ref. 23, p. 113). While $\Delta G/G_p$ is the notation that I use in my text, $\dot{G}/G$ (ratio of G-dot to G) is used in the referenced literature, where $\dot{G}$ is the rate of change of G per year and G is the accepted present value of G. The negative sign given in the measured data comes from the fact that the measurements are based on Dirac's theory[20] in which the universal gravitational constant G is assumed to be decreasing by time. Hence the negative sign represents this decrease in G. In other words, the measured values of $\dot{G}/G$ are positive values; a change in the sign is made in order to reflect the effect of decreasing G.

From these measurements it is gratifying to see that the figure given in expression (78) above, which represents the ratio of the annual rate of change of G to the present accepted value of G, is very much in line with the measured values.

Some of the ramifications of this slow but continuous increase in the value of gravity are discussed in Secs. 2.5 and 10.

8.6 Cosmological Constant of Em-Space

The cosmological constant λ was introduced by Einstein into his gravitational field equations (Ref. 3, pp. 63, 89), with the conjecture that with a sufficiently high mass density in the universe, it should be possible to "close" the universe.

> According to Einstein's general theory of relativity, the geometric properties of space are related to the density of energy in the universe. The most obvious energy sources that come to mind are ordinary matter and radiation. A much less obvious source of energy that can have an enormous impact on the structure of the universe is empty space itself: the vacuum. (Ref. 28, p. 72)

The following statement expresses the present general belief among scholars:

> It has been recognized that the dominant source of gravitational distortion in the space-time geometry of the universe at large scales appears to be the energy density of matter and not that of the vacuum. Although the energy density of matter and that of the vacuum both affect the geometric structure of the universe, they do so in different and distinguishable ways. (Ref. 28, p. 77)

The cosmological constant is defined as (Ref. 3, p. 88)

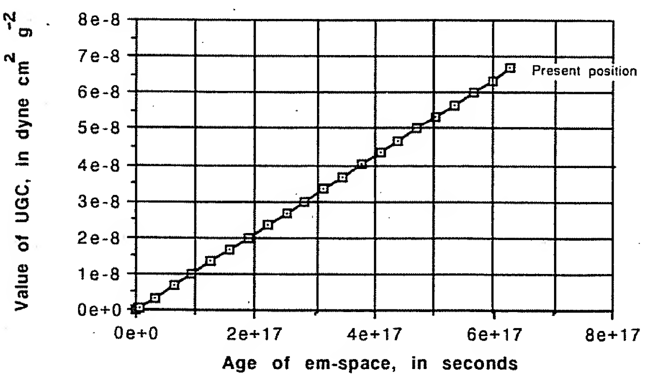

Figure 10. Universal gravitational constant G versus the age of em-space.

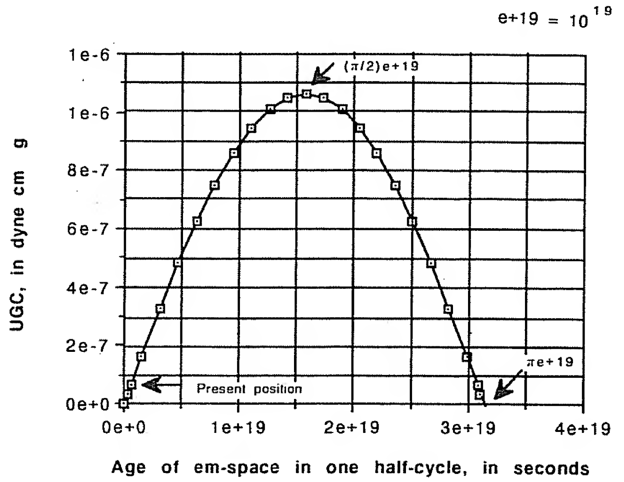

Figure 11. Universal gravitational constant G over one half cycle of em-space.

$$\lambda = 4\pi G\rho/c^2 \text{ cm}^{-2}, \tag{79a}$$

where ρ is the mass density of em-space (see Table I), G is the universal gravitational constant, and c is the speed of light. Defined in this way, the cosmological constant has units of one over distance squared. Narlikar (Ref. 3, p. 89), using a radius of $l = 10^{29}$ cm and a $\rho = 10^{-31}$ g·cm^{-3}, gives a value of 10^{-58} cm^{-2} for λ.

By using the mass density $\rho = 3.576 \times 10^{-29}$ g·cm^{-3}, calculated in this paper as the mass density for the present volume of em-space, in Eq. (79a) above we find the following value for the cosmological constant of em-space:

$$\lambda = \frac{4\pi \times 6.6726 \times 10^{-8} \times 3.567 \times 10^{-29}}{(3 \times 10^{10})^2} \text{ cm}^{-2}, \tag{79b}$$

or

$$\lambda = 3.332 \times 10^{-56} \text{ cm}^{-2}. \tag{79c}$$

This value of λ is about two orders of magnitude greater than that given by Narlikar (Ref. 3, p. 89).

In a similar manner, for example, when em-space was 10^8 s old (about 3 years), its mass density was 8.842 g·cm^{-3} (see Table I, about 9 times the density of water), and its G had a value of 1.0627×10^{-17} dyn·cm^2·g^{-2} (see Table VII). From these values the value of λ is calculated to have a value of 1.312×10^{-36} cm^{-2}, which is about 19 orders of magnitude greater than its present value. Thus for some time in the very early past of em-space, em-space must have been opaque to both matter particles and radiation (photons).

8.7 Redshift in the Frequency of Light From Distant Objects in the Expanding Em-Space

The question of redshift in the frequency of light coming from distant nebulas is rather a debated one. Redshift has been attributed to velocity shifts due to the Doppler effect in an expanding universe, to the "tired light" concept in which light gets to be aged as it travels through space filled with plasma,[7] or to scattering of light in the plasma-filled space.[8,9]

In the theory presented in this paper, my Eq. (5), where $l = ct$, is an expression of the expansion of em-space, and this expansion of em-space would cause galaxies and other distant objects of the matter universe to recede from each other. I therefore view the redshift observed in the frequency of light coming from a distant nebula as being at least a recession-related phenomenon, for example, Hubble's law, as seen in the expression $\vartheta_r = cz$ in which redshift is related to the recession speed of a nebula from our galaxy and the speed of light (Ref. 3, p. 21). Similarly, redshift calculated by using the Doppler effect defined by Eq. (80) given below (Ref. 24, p. 915) is also related to the recession velocity of receding objects and the speed of light.

In this paper I have also developed an alternative expression for the redshift using what I call the "photon energy loss effect," which also relates the redshift to the recession velocity of receding objects and the expansion velocity of em-space (see Sec. 8.7.3 below). Therefore, it may be said with confidence that the observed redshift is an indication of an expanding em-space (or universe). Below I give some details regarding redshift as calculated by using these three methods.

8.7.1 *Redshift Calculated Using Hubble's Law*

Hubble's law is given in the form of $\vartheta_r = cz = H_0D$ (Ref. 3, p. 21). From this it is observed that this relation limits neither the recession velocity nor the distance between the objects and the observer. In other words, the recession speed can be greater than the speed of light, which contradicts the rule that no speed can surpass the speed of light. According to the Hubble's law, when $z = 1$, the recession speed already equals the speed of light. Also, according to this law, the redshift can become infinite

Table I: The Estimated Age, Radius, Expansion Speed, Volume, and Mass Density of Em-Space

t, *age of em-space* (s)	l, *radius of em-space* (cm)	*Expansion speed* (% *of* c)	V, *volume of em-space* (cm^3)	ρ, *mass density of em-space* ($g \cdot cm^{-3}$)
0 [a]	0	100.00	0	?
10^{-43}	3×10^{-33}	100.00	1.1310×10^{-97}	8.842×10^{153}
10^{-30}	3×10^{-20}	100.00	1.1310×10^{-58}	8.842×10^{114}
10^{-20}	3×10^{-10}	100.00	1.1310×10^{-28}	8.842×10^{84}
10^{-10}	3×10^{0}	100.00	1.1310×10^{2}	8.842×10^{54}
10^{0}	3×10^{10}	100.00	1.1310×10^{32}	8.842×10^{24}
10^{1}	3×10^{11}	100.00	1.1310×10^{35}	8.842×10^{21}
10^{2}	3×10^{12}	100.00	1.1310×10^{38}	8.842×10^{18}
10^{3}	3×10^{13}	100.00	1.1310×10^{41}	8.842×10^{15}
10^{4}	3×10^{14}	100.00	1.1310×10^{44}	8.842×10^{12}
10^{5}	3×10^{15}	100.00	1.1310×10^{47}	8.842×10^{9}
10^{6}	3×10^{16}	100.00	1.1310×10^{50}	8.842×10^{6}
10^{7}	3×10^{17}	100.00	1.1310×10^{53}	8.842×10^{3}
10^{8}	3×10^{18}	100.00	1.1310×10^{56}	8.842×10^{0}
10^{9}	3×10^{19}	100.00	1.1310×10^{59}	8.842×10^{-3}
10^{10}	3×10^{20}	100.00	1.1310×10^{62}	8.842×10^{-6}
10^{11}	3×10^{21}	100.00	1.1310×10^{65}	8.842×10^{-9}
10^{12}	3×10^{22}	100.00	1.1310×10^{68}	8.842×10^{-12}
10^{13}	3×10^{23}	100.00	1.1310×10^{71}	8.842×10^{-15}
10^{14}	3×10^{24}	100.00	1.1310×10^{74}	8.842×10^{-18}
10^{15}	3×10^{25}	100.00	1.1310×10^{77}	8.842×10^{-21}
10^{16}	3×10^{26}	99.999 95	1.1310×10^{80}	8.842×10^{-24}
10^{17}	3×10^{27}	99.995	1.1310×10^{83}	8.842×10^{-27}
5×10^{17}	1.5×10^{28}	99.875	1.4137×10^{85}	7.082×10^{-29}
6×10^{17}	1.8×10^{28}	99.820	2.4423×10^{85}	4.094×10^{-29}
$2\pi \times 10^{17}$ [b]	1.883×10^{28}	99.803	2.7967×10^{85}	3.576×10^{-29}

[a] Time at transition point.
[b] These figures represent the case for the present age of em-space (universe).

as distance to the light-emitting object goes to infinity, that is to say, the universe is an open-ended system.

ϑ_r/c, z, ϑ_r, and D calculated using Hubble's law are shown in Table II.

8.7.2 *Redshift Calculated Using the Doppler Effect*

The change in the wavelength, corresponding to the redshift in the frequency of the light coming from a receding object, may be considered as being due to velocity shifts and may be calculated using Eq. (80), below which is an expression of the Doppler effect at speeds comparable to the speed of light (Ref. 24, p. 915). The expression is given as

$$\frac{\lambda'}{\lambda} = \frac{\sqrt{1 - (\vartheta_r/c)^2}}{1 - \vartheta_r/c} = 1 + z, \tag{80}$$

where λ is the wavelength of the emitted light, λ' the wavelength of the redshifted light, z the redshift, ϑ_r the recession speed of the light-emitting object, and c the speed of light. In this expression one can calculate the redshift z in the frequency of light of an object receding at the speed of ϑ_r by using a series of values for the ϑ_r/c ratio. In this way, ϑ_r can be calculated and plotted against z. In addition, by using Hubble's law relating ϑ_r to the distance, that is, $\vartheta_r = H_0 D$, the distance versus the redshift can be calculated.

ϑ_r/c, z, ϑ_r, and D, the time taken by light to travel distance D, and the age of em-space at which the light was emitted are shown in Table III. Some details for the data in Table III are defined below:

Column A: Selected values of ϑ_r/c. A maximum value of 99.8% of c is used for ϑ_r/c, which is also the expansion speed of em-space ϑ_p at its present age. This limitation is due to the maximum distance that light may have to travel, which is the size of the radius of em-space at its present epoch. This is calculated to be 6105 Mpc.

Column B: The calculated values of redshift due to the Doppler effect corresponding to the ϑ_r/c values in Column A are shown here. The calculated redshift value corresponding to the maximum value of ϑ_r/c is 30.61.

Column C: The recession speed ϑ_r in km/s calculated by using the ϑ_r/c ratio given in Column A is shown in this column.

Table II: Recession Speed and Distance versus Redshift Using Hubble's Law Relation

A *Recession speed/c; c is speed of light* ϑ_r/c	B *Redshift calculated using Doppler relation; z values correspond to* ϑ_r/c *values in Column A*	C *Recession speed using Hubble's law* $\vartheta_r = cz$; *calculated values correspond to values in Column B (in km/s)*	D *Hubble's distance using* $\vartheta_r = H_0 \times D$ *corresponding to values in Column C (in Mpc)*
0.001	0.001 001	300.3	6.12
0.002	0.002 002	600.6	12.25
0.003	0.003 005	901.5	18.38
0.004	0.004008	1202.4	24.52
0.005	0.005 013	1503.9	30.67
0.006	0.006 018	1805.4	36.81
0.007	0.007 025	2107.5	43
0.008	0.008 032	2409.6	49.1
0.009	0.009 041	2712.3	55.31
0.01	0.01 005	3015	61.48
0.02	0.02 021	6063	123.6
0.03	0.03 046	9138	186.3
0.04	0.04 083	12 249	250
0.05	0.05 013	15 039	307
0.06	0.06 191	18 573	379
0.07	0.07 263	21 789	444
0.08	0.08 347	25 041	510
0.09	0.09 444	28 332	578
0.1	0.106	31 800	648
0.2	0.225	67 500	1376
0.3	0.363	108 900	2220
0.4	0.528	158 400	3230
0.5	0.732	219 600	4478
0.6	1	300 000	6117
0.7	1.381	414 300	8448
0.8	2	600 000	12 235
0.9	3.359	1 007 700	20 548
0.91	3.607	1 082 100	22 066
0.93	4.251	1 275 300	26 005
0.95	5.225	1 567 500	31 964
0.97	7.103	2 130 900	43 452
0.99	13.107	3 932 100	80 181
0.991	13.874	4 162 200	84 873
0.992	14.78	4 434 000	90 416
0.993	15.873	4 761 900	97 102
0.994	17.23	5 169 000	105 404
0.995	18.975	5 692 500	116 079
0.996	21.338	6 401 400	130 534
0.997	24.801	7 440 300	151 719
0.998	30.607	9 182 100	187 237

Column D: The values of distances calculated by using the relation $\vartheta_r = H_0 D$ are shown in this column. As it is pointed out in Sec. 5.3, the theory presented in this paper finds a recession speed of $\vartheta_{rec} = 49.04$ km/s at a distance of 1 Mpc, which is the same as the Hubble constant H_0 [see Eq. (31a)], thus aligning itself with the Hubble constant within the range of 30 to 60 proposed by Sandage and Tammann, rather than the range of 70 to 110 proposed by De Vaucouleurs (Ref. 29, p. 23).

Column E: Travel times, in billion years, taken by a light signal emitted from a receding object at the distances D given in Column D, to reach the observer are shown in this column. The travel time is calculated by using the relation $t = D/c$.

Column F: This column shows the age of em-space, in billion years, at which the light was emitted from an object. The age is calculated using the relation $t = t_p - t_t$, where t is the age at which light was emitted, t_p is the present age of em-space (19.92 billion years), and t_t is the travel time of light (Column E).

Table III: Recession Speed, Distance, Time to Travel Over Distance D, and the Age of Em-Space at Which Light Was Emitted versus Redshift Using the Doppler Shift Relation

A *Recession speed/c; c is speed of light* ϑ_r/c	B *Redshift calculated using Doppler relation; z values correspond to* ϑ/c *values in Column A*	C *Recession speed using values in Column A times the speed of light* ϑ_r *(in km/s)*	D *Distance to galaxy* $D = \vartheta_r/49.04$ D *(in Mpc)*	E *Time to travel over distance* D $t = (D \times 3.26)/1000$ *(in billion yr)*	F *Age of em-space at time of light emission* $t_1 = t_p - t$ $t_p = 19.92$ *(in billion yr)*
0.001	0.001 001	300	6.12	0.0199	19.9
0.002	0.002 002	600	12.24	0.0399	19.88
0.003	0.003 005	900	18.35	0.0598	19.86
0.004	0.004 008	1200	24.47	0.0798	19.84
0.005	0.005 013	1500	30.59	0.0997	19.82
0.006	0.006 018	1800	36.71	0.12	19.8
0.007	0.007 025	2100	42.82	0.14	19.78
0.008	0.008 032	2400	48.94	0.16	19.76
0.009	0.009 041	2700	55.06	0.18	19.74
0.01	0.01 005	3000	61.17	0.199	19.72
0.02	0.02 021	6000	122.35	0.399	19.52
0.03	0.03 046	9000	183.52	0.598	19.32
0.04	0.04 083	12 000	244.7	0.798	19.12
0.05	0.05 013	15 000	305.87	0.997	18.92
0.06	0.06 191	18 000	367.05	1.2	18.72
0.07	0.07 263	21 000	428.22	1.4	18.52
0.08	0.08 347	24 000	489.4	1.6	18.32
0.09	0.09 444	27 000	550.57	1.8	18.13
0.1	0.106	30 000	611.75	1.99	17.93
0.2	0.225	60 000	1223.49	3.99	15.93
0.3	0.363	90 000	1835.24	5.98	13.94
0.4	0.528	120 000	2446.98	7.98	11.94
0.5	0.732	150 000	3058.73	9.97	9.95
0.6	1	180 000	3670.47	11.96	7.96
0.7	1.381	210 000	4282.22	13.96	5.96
0.8	2	240 000	4893.96	15.95	3.97
0.9	3.359	270 000	5505.71	17.95	1.97
0.91	3.607	273 000	5566.88	18.15	1.77
0.93	4.251	279 000	5689.23	18.55	1.37
0.95	5.225	285 000	5811.58	18.95	0.97
0.97	7.103	291 000	5933.93	19.35	0.57
0.99	13.107	297 000	6056.28	19.74	0.18
0.991	13.874	297 300	6062.4	19.76	0.16
0.992	14.78	297 600	6068.52	19.78	0.14
0.993	15.873	297 900	6074.63	19.8	0.12
0.994	17.23	298 200	6080.75	19.82	0.1
0.995	18.975	298 500	6086.87	19.84	0.08
0.996	21.338	298 800	6092.99	19.86	0.06
0.997	24.801	299 100	6099.1	19.88	0.04
0.998	30.607	299 400	6105	19.92	0

8.7.3 *Redshift Due to Some Phenomenon Involving Photon Energy Loss*

A photon, that is, a packet of light quanta, has a certain energy associated with it. This energy is defined by Einstein's photon theory (Ref. 24, p. 1090) as $E = h\nu$, where h is Planck's constant given as 6.625×10^{-34} J · s, and ν is the frequency. Let us assume that as a photon travels through the fabric of em-space, it interacts with it in such a way that, without defining the exact nature of the interaction, it loses some of its energy and thus becomes redshifted. It should be noted here that this idea is similar to the one expressed by Hubble (Ref. 4, p. 193) and also the one used by the "tired light" model of cosmology

as introduced in Sec. 1.3, the proponents of which used the concept to calculate the CBR, although considered by them for a nonexpanding universe.[7] The lost energy, ΔE, of the photon may be expressed as follows:

$$\Delta E = h\nu - h\nu' = h\left[\frac{c}{\lambda} - \frac{c}{\lambda'}\right] = KD, \qquad (81a)$$

where c is the speed of light, and λ and λ' are the initial and redshifted wavelengths corresponding to the frequencies ν and ν', respectively. K is a constant that may be termed the "photon energy loss factor," which needs to be determined, and D is the distance between a distant object and the observer over which light travels. Expression (81a) can be rearranged in the following form:

$$h\left[\frac{c}{\lambda} - \frac{c}{\lambda'}\right] = hc\left[\frac{\lambda' - \lambda}{\lambda\lambda'}\right] = \frac{hcz}{\lambda'} = KD, \qquad (81b)$$

where the redshift z is defined as $z = (\lambda' - \lambda)/\lambda$ and $\lambda' = (1 + z)\lambda$. Thus Eq. (81b) becomes

$$\frac{hcz}{\lambda'} = \frac{hcz}{(1 + z)\lambda} = KD, \qquad (81c)$$

which can be rearranged for z as

$$z = \frac{1}{hc/\lambda KD - 1}. \qquad (81d)$$

In Eq. (81d) the $hc/\lambda KD$ in the denominator can approach the value of 1 but must not be less than 1, so that z does not become negative. As a limit, let us say that $hc/\lambda KD = 1$. From this we get for the constant K

$$K = hc/\lambda D. \qquad (81e)$$

In this limit condition we use for distance D the present size of the radius of em-space l_p in megaparsecs, which is defined as η and has a value of 6105 Mpc in Eq. (29b), as the maximum value for distance. For the reference wavelength λ I have chosen a value of 4.4×10^{-7} m, which is in the violet region of the spectrum (considering the fact that K-H absorption lines of calcium have been used by Hubble and others for the determination of the redshift in observations of light from nebulas that are also in the violet region of the spectrum). Thus, when we insert values of all the elements in this expression, we get

$$K = \frac{hc}{\lambda D} = \frac{hc}{\lambda\eta} = \frac{6.625 \times 10^{-34} \times 3 \times 10^{8}}{4.4 \times 10^{-7} \times 6105}, \qquad (81f)$$

$$K = 7.4 \times 10^{-23}\ \text{J/Mpc}. \qquad (81g)$$

From Eqs. (29a) and (29b), for any value of D we have the expression $\vartheta_r = D\vartheta_{rec} = D\vartheta_p/\eta$, where ϑ_r is the recession speed at any distance D, ϑ_{rec} is the recession speed at 1 Mpc in km/s (which has the same definition as the Hubble constant H_0), and η is as defined in Eq. (29b). After inserting these parameters in Eq. (81d) for D, the expression becomes

$$z = \frac{1}{hc\vartheta_p/\lambda K\eta\vartheta_r - 1}. \qquad (81h)$$

If we use $K = hc/\lambda\eta$ in this expression as defined in Eq. (81f) above, we get

$$z = \frac{1}{\vartheta_p/\vartheta_r - 1}, \qquad (81i)$$

which makes z a function of only ϑ_p and ϑ_r, that is, the expansion speed of em-space at its present age and the recession speed of a nebula at any distance, respectively. When Eq. (81i) is rearranged for ϑ_r, we have

$$\vartheta_r = \frac{\vartheta_p z}{1 + z}. \qquad (81j)$$

In comparison with Hubble's law $\vartheta_r = cz$, we find that Eq. (81j) has a form that signifies modification to Hubble's law. With this, we have an expression relating the recession speed of a receding galaxy in em-space to the expansion speed of em-space at its present age and the redshift observed in the frequency of light from the galaxy. In this paper ϑ_p has been calculated to have a value of 99.8% of the speed of light.

In Eq. (81j) it should be noted that the calculated value of ϑ_r approaches that of ϑ_p, the speed of expansion of em-space, but never exceeds it as the redshift z becomes larger and larger. Since the redshift in the light coming from a distant nebula can be measured quite accurately by means of the modern technology used in observational astronomy, after measuring z and by using Eq. (81j), one can also calculate the recession speed of the object with confidence.

In Eq. (81d), by using $\eta = hc/\lambda K$, we also get the following expression:

$$z = \frac{1}{\eta/D - 1}, \qquad (82a)$$

or

$$D = \frac{\eta z}{1 + z}, \qquad (82b)$$

where η is the present size of the radius of em-space in megaparsecs, that is, 6105 Mpc, and D is the distance of the receding object to the observation post in the expanding em-space. The calculated values of z using Eq. (82a) are the same as those found by using Eq. (81j).

Table IV shows the values of z, ϑ_r, and D, the time taken by light to travel distance D, and the age of em-space at which the light was emitted, calculated using Eqs. (81d) to (81j).

8.7.4 *Discussion*

In Fig. 12 the recession speeds of distant objects as calculated using Hubble's law, the Doppler effect [i.e., using Eq. (80)], and the "photon energy loss" relation represented by Eq. (81j) or (82a) are plotted against the redshift. Similarly, in Fig. 13 the distance to an object is plotted against the redshift. In these figures we note the following:

(1) The calculated recession speeds and the corresponding distances to the receding objects in all three relations coincide with each other for values of z between zero and about $z = 0.1$ with negligible differences. After this point, the calculated values of the recession speeds and distances calculated using these three methods start differing from each other.

In view of this, it may be argued that Hubble's law $\vartheta_r = cz$ and $cz = H_0D$ may be valid and accurate only for values of $z \leq 0.1$. For $z > 0.1$, $\vartheta_r = cz$ requires modification so that ϑ_r does not exceed the speed of light. Modification to ϑ_r would also limit D to the present size of em-space.

(2) For $z > 1$ the recession speed calculated by Hubble's law exceeds the speed of light and goes to infinity; yet the recession speed calculated by the Doppler effect and the one calculated using Eq. (81j) approach the speed of light at the limit. For $z > 0.1$, the recession speed calculated by the Doppler effect is greater than the one calculated using Eq. (81j). While the recession speed calculated by the Doppler effect reaches the value of the speed of light at about $z = 31$, the recession speed calculated using Eq. (81j) reaches the speed of light only after about $z = 1035$.

(3) The relation given by Eq. (81j) is a likely alternative to both Hubble's law $\vartheta_r = cz$ and the Doppler shift relation given by Eq. (80).

(4) The relations presented above all are indicative of an expanding universe. In such a universe, as a result of the expansion of em-space, galaxies would be receding from each other at recession velocities that vary with the distance between the galaxies.

(5) In Eqs. (81d) and (81h) we also have the redshift expressed in terms of h, c, λ, and K, which finally drop out and the redshift becomes a function of the recession speed of galaxies and the expansion speed of em-space only.

(6) The redshift data in Column B of Tables III and IV can be plotted versus data in any other column, since they are related to each other. In Figs. 12 to 14 the recession speed, the distance to the object, the time taken by the emitted light to travel the distance between the object and the observer, and the age of em-space at which light was emitted from an observed object are plotted, respectively, against the expected redshift in the expanding em-space.

(7) Observing quasars with redshifts in the range[26] of 4 to 5 and thus correspondingly with recession speeds between 90% and 95% of the speed of light seems to be an indirect verification of one of the cornerstone statements of the theory presented in this paper, that is, "the initial expansion speed of em-space was at the speed of light." At the present age of em-space its expansion speed has slowed down to 99.8% of c.

(8) Observations of quasars with redshifts[26] 4.25 or more indicate that some quasars could have formed as early as about 1 billion years (see also Sec. 10.3).

(9) Finally, in view of the presentation made in this section, that is, Sec. 8.7, it may be said with confidence that the observed redshift in the frequency of light is due to a phenomenon that itself is a recession velocity-related event and is a result of the expansion of em-space.

9. THE HORIZON AT AN OBSERVATION POINT IN EM-SPACE

9.1 An Observation Point in the Expanding Em-Space

Figure 15 represents a cross section of the expanding em-space at a time t, where t may have any value between 0 and t_p, the present age of em-space. An observation point, say, OP′, is located along the horizontal axis between points TP (transition point) and B. We have the following definitions:

t: The age of em-space in the past at which a 2θ solid angle portion of which is presently visible from an observation point OP that is located at a point along a radial of the expanding em-space.

θ: The angle of visibility, in degrees, apexed at the TP, where one side of it passes through the point OP. The angle θ can have values between 0° and 180°. It encloses part of em-space which is visible at point OP at its present age.

$t_{\theta=180°}$: Full visibility age. The age of em-space at which all structured objects of the matter universe contained in the total volume of em-space at that age would be visible now at a particular position along a radial of em-space. In other words, all objects born to shine at $t_{\theta=180°}$ or earlier would be visible to OP at the present age of em-space.

$t_{\theta=0°}$: Visibility cutoff age. The age of em-space at which the angle of visibility becomes zero, meaning that all objects of the matter universe born into em-space after $t_{\theta=0°}$ are not yet visible at the point OP. Objects of the matter universe having been born into em-space before the age $t_{\theta=0°}$ would be visible to point OP in accordance with their age.

α: A proportionality factor relating the position of a point OP along a radial of the expanding em-space to its radius. For example, if the distance of an object, such as a galaxy, to point TP was, say, x cm at the time t that it started to emit light into em-space, the ratio of x to the radius l of em-space at that age, given by $l = (c/p)\sin pt$, gives the proportionality factor α. The value of α for a particular spot at any age of em-space also holds true after em-space has expanded to another size such as the present radius, which is given by $l_p = (c/p)\sin pt_p$. Hence, if an

Table IV: Recession Speed, Distance, Time to Travel Over Distance D, and the Age of Em-Space at Which Light Was Emitted versus Redshift Using Eq. (81j) or Eq. (82a)

A *Recession speed/c;* *c is speed of light* ϑ_r/c	B *Redshift calculated using photon energy loss effect* $z = 1/(6105/D - 1)$ or $z = 1/(\vartheta_p/\vartheta_r - 1)$	C *Recession speed using values in Column A times the speed of light;* ϑ_r *(in km/s)*	D *Distance to galaxy* $D = \vartheta_r/49.04$ D *(in Mpc)*	E *Time to travel over distance* D $t = (D \times 3.26)/1000$ *(in billion yr)*	F *Age of em-space at time of light emission* $t_l = t_p - t$ $t_p = 19.92$ *(in billion yr)*
0.001	0.001 003	300	6.12	0.0199	19.9
0.002	0.002 009	600	12.24	0.0399	19.88
0.003	0.003 015	900	18.35	0.0598	19.86
0.004	0.004 024	1200	24.47	0.797	19.84
0.005	0.005 036	1500	30.59	0.0997	19.82
0.006	0.00 605	1800	36.71	0.12	19.8
0.007	0.007 063	2100	42.82	0.14	19.78
0.008	0.008 081	2400	48.94	0.16	19.76
0.009	0.009 101	2700	55.06	0.18	19.74
0.01	0.01 012	3000	61.17	0.199	19.72
0.02	0.02 045	6000	122.35	0.399	19.52
0.03	0.03 099	9000	183.52	0.598	19.32
0.04	0.04 176	12 000	244.7	0.798	19.12
0.05	0.05 274	15 000	305.87	0.997	18.92
0.06	0.06 397	18 000	367.05	1.2	18.72
0.07	0.07 543	21 000	428.22	1.4	18.52
0.08	0.08 715	24 000	489.4	1.6	18.32
0.09	0.09 912	27 000	550.57	1.8	18.13
0.1	0.1114	30 000	611.75	1.99	17.93
0.2	0.2506	60 000	1223.49	3.99	15.93
0.3	0.4298	90 000	1835.24	5.98	13.94
0.4	0.6689	120 000	2446.98	7.98	11.94
0.5	1.004	150 000	3058.73	9.97	9.95
0.6	1.508	180 000	3670.47	11.97	7.96
0.7	2.349	210 000	4282.22	13.96	5.96
0.8	4.041	240 000	4893.96	15.95	3.97
0.9	9.187	270 000	5505.71	17.95	1.97
0.91	10.345	273 000	5566.88	18.15	1.77
0.93	13.684	279 000	5689.23	18.55	1.37
0.95	19.806	285 000	5811.58	18.95	0.97
0.97	34.687	291 000	5933.93	19.34	0.57
0.99	124.308	297 000	6056.28	19.75	0.18
0.991	142.31	297 300	6062.4	19.76	0.16
0.992	166.352	297 600	6068.52	19.78	0.14
0.993	200.021	297 900	6074.63	19.8	0.12
0.994	250.753	298 200	6080.75	19.82	0.1
0.995	335.735	298 500	6086.87	19.84	0.08
0.996	507.326	298 800	6092.99	19.86	0.06
0.997	1033.746	299 100	6099.1	19.88	0.04
0.998		299 400	6105		0

object was, say, $x = \alpha l$ cm away from the TP at the age of t s from TP, it is at a distance of $y = \alpha l_p$ cm from TP now at age t_p. The factor α can have values between 0 and 1.

With these definitions let us examine the scenario depicted in Fig. 15 in which the following distances are defined :

Distance from TP to point A: $l = (c/p) \sin pt$
Distance from point TP to point B: l
Distance from point B to point C: Δl, the amount of distance em-space expanded during $\Delta t = t_p - t$ s, $\Delta l = (c/p) \sin pt_p - (c/p) \sin pt$
Distance from TP to point OP′: $x = \alpha l$

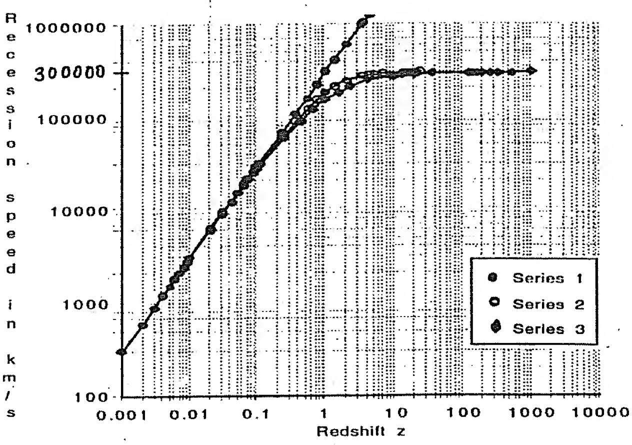

Figure 12. Recession speed of a nebula versus redshift. Series 1: using Hubble's law; series 2: using the Doppler relation; series 3: using the photon energy loss effect.

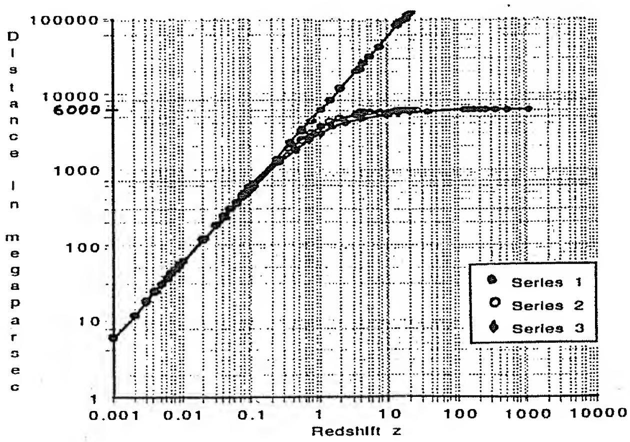

Figure 13. Distance to a distant nebula versus redshift. Series 1: using Hubble's law; series 2: using the Doppler relation; series 3: using the photon energy loss effect.

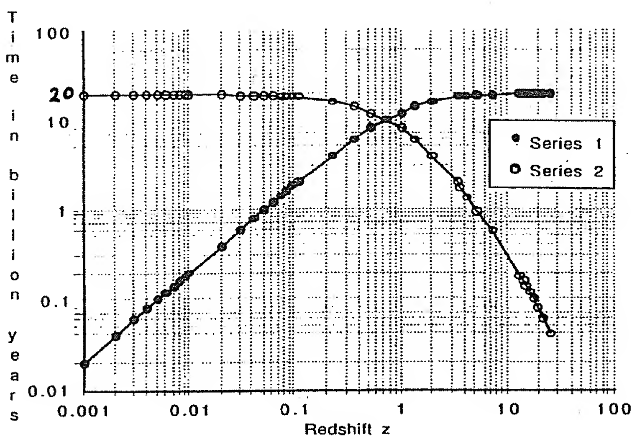

Figure 14(a). Time versus redshift using the Doppler relation (see Table III). Series 1: travel time of light from distant object; series 2: age of em-space at which light was emitted.

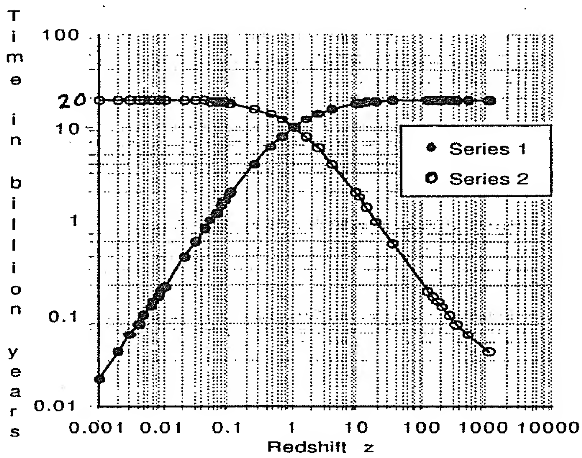

Figure 14(b). Time versus redshift using Eq. (81j) (see Table IV). Series 1: travel time of light from distant object; series 2: age of em-space at which light was emitted.

Distance from TP to point OP: $y = \alpha l_p = \alpha\,(c/p)\sin pt$
Distance from A to point OP: $l_c = c\Delta t = c(t_p - t)$, and $p = 10^{-19}\ \mathrm{s}^{-1}$ a constant as defined earlier in this paper.

Using the cosine law, we have

$$l_c^2 = l^2 + y^2 - 2ly\cos\theta\,, \tag{83}$$

$$\cos\theta = \frac{l^2 + y^2 - l_c^2}{2ly}\,. \tag{84}$$

After substituting the definitions of each term in this expression and canceling the $(c/p)^2$ factor from the equation, we have

$$\cos\theta = \frac{\sin^2 pt + \alpha^2\sin^2 pt_p - p^2(t_p - t)^2}{2\alpha\sin pt\sin pt_p}\,. \tag{85}$$

Equation (85) may be reduced further by allowing $\sin pt$ to be represented by pt for small values of pt as compared to pt_p. This will introduce only negligible errors in solving the expression for t. Then we have

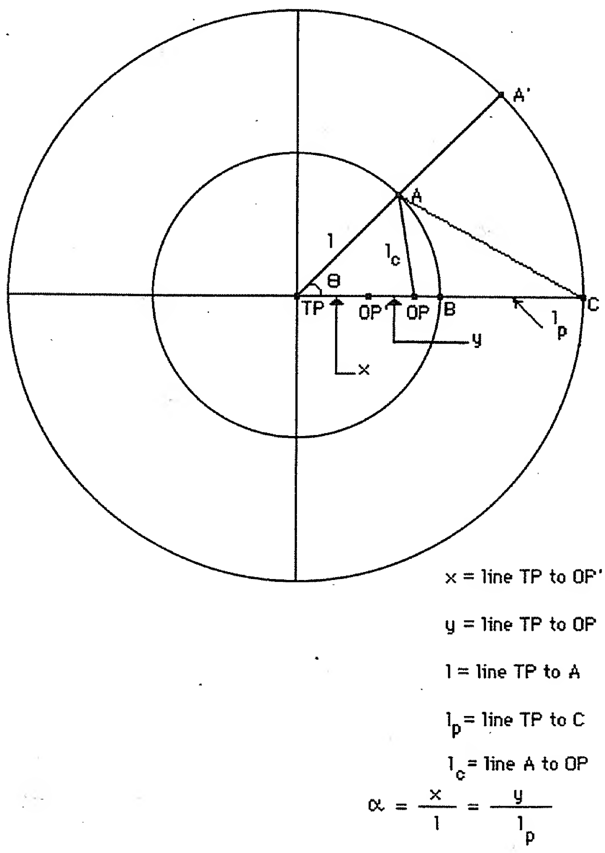

Figure 15. Visibility of em-space at an observation point OP.

$$\cos\theta = \frac{(pt)^2 + \alpha^2 \sin^2 pt_p - p^2(t_p - t)^2}{2\alpha pt \sin pt_p}, \tag{86}$$

which can be further reduced to

$$\cos\theta = \frac{\alpha^2 \sin^2 pt_p - p^2 t_p^2 + 2p^2 t t_p}{2\alpha pt \sin pt_p}. \tag{87}$$

We solve this expression for the following three cases.

Case 1. $\cos\theta = -1$ or $\theta = 180°$ in which we have for $t_{\theta=180°}$:

$$t_{\theta=180°} = \frac{pt_p - \alpha \sin pt_p}{2p}. \tag{88}$$

Equation (88) gives the "full visibility age" of em-space, with reference to the TP. The total size (spherical volume) of the universe at that time is fully visible from an observation point OP at the present age of em-space.

Case 2. $\cos\theta = 1$ or $\theta = 0°$ in which we have for $t_{\theta=0°}$:

$$t_{\theta=0°} = \frac{pt_p + \alpha \sin pt_p}{2p}. \tag{89}$$

Equation (89) gives the "visibility cutoff age" of em-space with respect to the TP. At this time the angle θ has zero value at the value of α used. The meaning of θ being zero is that light from objects born into em-space during the period between $t_{\theta=0°}$ and the present age t_p of em-space, did not have enough time to reach the observation point OP.

Case 3. $\cos\theta = 0$ or $\theta = 90°$ in which we have for $t_{\theta=90°}$:

$$t_{\theta=90°} = \frac{p^2 t_p^2 - \alpha^2 \sin^2 pt_p}{2p^2 t_p}. \tag{90}$$

Equation (90) gives the "half visibility age" of em-space, with reference to the TP. At this age, one-half of the size (one-half of the volume) of em-space at that age would be fully visible from an observation point OP at the present age of em-space.

The calculated values of $t_{\theta=180°}$, $t_{\theta=90°}$, and $t_{\theta=0°}$ for some specific values of α and the corresponding values of the radius of em-space are listed in Table V. The $l_{\theta=180°}$ versus α and $l_{\theta=0°}$ versus α are plotted in Figs. 16 and 17, respectively.

9.2 α-Related Visible Sky at an OP

In Fig. 15, when light from point A on the periphery of the expanding em-space started its journey towards point OP′, the age of em-space was, say, t yr from point TP. When that light reached point OP′, the age of em-space was t_p, the present age of em-space (about 19.92 billion years), and point OP′ had moved to point OP. During the time $t_p - t$, the point A also changed its position to the new position A′ in em-space. Hence what we are seeing now in the sky is the object A as it was at age t, not A′ at age t_p. In the meantime, light emitted from object A at the intermediary positions between A and A′ has not reached the observation point OP yet.

So, what is visible now at OP are all those objects that were born into em-space at or before the age of $t_{\theta=180°}$. In addition, we also see all those objects whose visibility angles are between 0° and 180°. As the birth date of objects becomes farther away from $t = 0$, the visibility angle of the sky where such objects are located becomes smaller. This means that at an observation point OP associated with an α value, objects filling the sky between the ages of $t_{\theta=180°}$ and $t_{\theta=0°}$ and filling the sky inside the visibility angle will also be seen at point OP. Those objects having the same age but filling em-space outside the visibility angle will not be seen at OP yet. Hence em-space between the ages $t_{\theta=180°}$ and $t_{\theta=0°}$ may be looked upon as a partially visible region of the universe.

Calculated values of the "visibility angle" θ between 180° and 0° and the corresponding age t of em-space for different values of α between 0 and 1 are plotted in Figs. 19 to 22. The visibility cutoff age, that is, $t_{\theta=0°}$ on each curve for each α value, takes

Table V: $t_{\theta=180°}$, $l_{\theta=180°}$; $t_{\theta=90°}$, $l_{\theta=90°}$; $t_{\theta=0°}$, $l_{\theta=0°}$ versus Different Values of α

α	$t_{\theta=180°}$ (s)	$l_{\theta=180°}$ (Mpc)	$t_{\theta=0°}$ (s)	$l_{\theta=0°}$ (Mpc)	$t_{\theta=90°}$ (s)	$l_{\theta=90°}$ (Mpc)
0.0	3.1416×10^{17}	3054	3.1416×10^{17}	3054	3.1416×10^{17}	3054
0.1	2.8276×10^{17}	2749	3.4560×10^{17}	3360	3.1102×10^{17}	3024
0.2	2.5137×10^{17}	2444	3.7703×10^{17}	3666	3.0161×10^{17}	2932
0.3	2.1997×10^{17}	2139	4.0847×10^{17}	3970	2.8592×10^{17}	2780
0.4	1.8858×10^{17}	1833	4.3991×10^{17}	4276	2.6396×10^{17}	2566
0.5	1.5718×10^{17}	1528	4.7134×10^{17}	4581	2.3572×10^{17}	2292
0.6	1.2579×10^{17}	1223	5.0278×10^{17}	4886	2.0121×10^{17}	1956
0.7	9.4392×10^{16}	918	5.3422×10^{17}	5192	1.6042×10^{17}	1560
0.8	6.2997×10^{16}	613	5.6565×10^{17}	5497	1.1336×10^{17}	1102
0.9	3.1602×10^{16}	307	5.9709×10^{17}	5802	6.0025×10^{16}	584
1.0	2.0667×10^{14}	2	6.2853×10^{17}	6108	4.1320×10^{14}	4

place $t_p - t_{\theta=C°}$ billion years ago with respect to the present age. The em-space between the ages of $t_{\theta=180°}$ and $t_{\theta=0°}$ that I have termed the "partially visible universe" is represented with the second ring in Fig. 18.

Using Eqs. (88) and (89), we develop the following three expressions for α:

$$\alpha = \frac{2pt_{\theta=0°} - pt_p}{\sin pt_p}, \tag{91a}$$

or

$$\alpha = \frac{pt_p - 2pt_{\theta=180°}}{\sin pt_p}, \tag{91b}$$

or

$$\alpha = \frac{p(t_{\theta=0°} - t_{\theta=180°})}{\sin pt_p}. \tag{91c}$$

From these expressions for α, it is seen that if one knew the values of the related terms for a given object in em-space, one might be able to define a special position along a radial of em-space.

Visibility of the universe from an observation point OP associated with different α values is plotted in Figs. 19 to 22.

From Eqs. (88) and (89) one may also obtain the following relation involving the specific ages of $t_{\theta=180°}$ and $t_{\theta=0°}$ given in Table V:

$$t_p = t_{\theta=180°} + t_{\theta=0°}. \tag{92}$$

The factor α defined by Eqs. (91a) to (91c) determines the position of an observation point OP along a radial of the expanding em-space.

When $\alpha = 0$, the position of OP is at the center of em-space. For such an observation point, the matter universe existed in em-space at the age of $t_p/2$ billion years and is fully visible now, that is, one-eighth of the present volume of em-space and the embedded matter universe. In addition, those objects born into the same volume of em-space (i.e., defined by the volume with radius $l_p/2$ at the age of t, where t is greater than $t_p/2$) and at distances equal to or less than $c(t_p - t)$ from an observation point OP that is at TP, will also be visible to OP. However, objects born into the volume of em-space confined between the radii of l_p and $l_p/2$ (i.e., the volume at l_p minus the volume at $l_p/2$, which is seven times the visible volume), after the age of $t_p/2$ billion years would not be visible at OP yet.

On the other hand, when α is 1, the observation point OP is at the edge of the expanding em-space. For such an observation point, the size of the visible portion of em-space would be about 2 Mpc, corresponding to the age of about 6.622 million years ($t = 2.0667 \times 10^{14}$ s) from TP. The visibility cutoff age for this scenario is t_p, the present age of em-space.

At such an observation point, for example, only the contents of a small sector of the spherical em-space centered at about $2\theta = 18°$ at the age of 1 billion years would be visible at OP now. As the age of the universe increases from 1 billion years to its present age, the visibility angle diminishes to very small values, such as 0.18° at 18.92 billion years. Thus the sky at such an observation point would probably be limited only to the visible environment of the galaxy where the observation point is located and its local group of galaxies. The sky at such an observation point would be quite lopsided, that is, not symmetrical. The early visible universe having an age of 1 billion years would probably appear in the sky like a globular galaxy at a very great distance. The data for the visibility angle versus the age of em-space for the $\alpha = 1$ scenario are plotted in Fig. 22.

A "full visibility age" and a "visibility cutoff age" are associated with each observation point having an α value between 0 and 1. Those objects born into em-space between the ages of

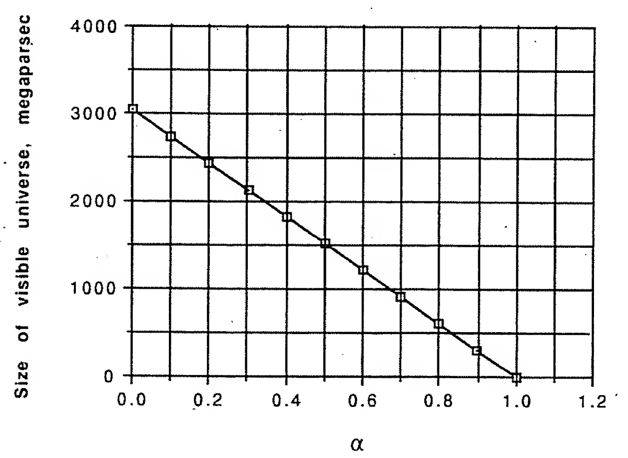

Figure 16. Size of visible universe from an observation point OP associated with α values between 0 and 1.

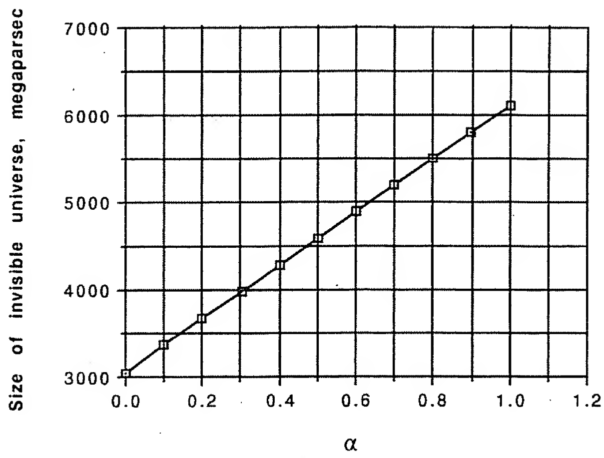

Figure 17. Size of invisible universe from an observation point OP associated with α values between 0 and 1.

$t_{\theta=180°}$ and $t_{\theta=0°}$ and at distances $\leq c(t_p - t)$ from the observation point OP will be visible at such an OP. However, objects born into the volume of em-space confined between the radii of l at the age of $t_{\theta=0°}$ and l_p at the age of t_p (i.e., volume at l_p minus the volume at l) would not be visible at OP yet. The visible sky associated with scenarios where $\alpha > 0.5$ would probably show lopsidedness. Lopsidedness means that due to the particular position of the observation point OP in em-space, the thickness of the visible matter universe may be greater in one particular direction than in the direction opposite to it.

9.3 Visible Portion of Em-Space as Percent of Total Volume

Figure 23 shows the sector of a sphere enclosed by an angle 2θ. We have the volume of the sector of a sphere (Ref. 30, p. 1034) whose radius is r, which is given by $(c/p)\sin pt$ in the case of em-space, and height is h, as

$$\mathrm{Vol}_{\mathrm{sector}} = 2\pi r^2 h/3. \tag{93}$$

The height h may be defined in terms of r and θ as follows:

$$h = r - r\cos\theta = r(1 - \cos\theta). \tag{94}$$

Thus the volume of a sector of a sphere becomes

$$\mathrm{Vol}_{\mathrm{sector}} = 2\pi r^3 (1 - \cos\theta)/3. \tag{95}$$

The ratio of this volume to the total volume of the sphere is

$$\frac{\mathrm{Vol}_{\mathrm{sector}}}{\mathrm{Vol}_{\mathrm{sphere}}} = \frac{[2\pi r^3(1 - \cos\theta)]/3}{4\pi r^3/3}, \tag{96a}$$

or

$$\frac{\mathrm{Vol}_{\mathrm{sector}}}{\mathrm{Vol}_{\mathrm{sphere}}} = \frac{1 - \cos\theta}{2}. \tag{96b}$$

Using the radius and the visibility angle θ at different ages in Eq. (95), the volume of the sector enclosed by the visibility angle 2θ can be calculated. For example, Table VI lists the values of the visibility angle θ, the corresponding age from TP of em-space, and the volume of em-space at that age which is visible at an observation point associated with $\alpha = 0.5$.

The data could be interpreted as follows: suppose that when em-space was, say, $t_1 = 4.974\,25$ billion years old, that is, 14.945 75 billion years ago, there were X number of objects of the matter universe in it. Hence their ages with respect to t_p is $t_p - t_1$ billion years or older. As seen from Table VI, the visibility angle corresponding to this age is $\theta = 180°$. What this table is telling us is that now at the age of t_p, if we, as observers, are at an OP associated with $\alpha = 0.5$, then we are seeing (or should be seeing) all of those X numbers of objects belonging to that era in the sky of the present-day universe.

Let us proceed with the expansion of em-space into the age of, say, $t_2 = 6$ billion years (i.e., 13.92 billion years ago), and let Y number of new objects be born into em-space during the period from t_1 to t_2. With the visibility angle θ being 119° at t_2, we would be seeing (or should be seeing) about 74% of Y number objects from the era of t_2 now. Similarly, if there were Z number of new objects in the time period between 6 and 7 billion years of age, then we should be seeing about 56% of the Z number of objects in the universe around us now, and so on.

As we go down the "% of Volume" column of Table VI, we would expect to see gradually decreasing percentages of objects born in the matter universe at consecutive eras in the life span of em-space visible to us now. If it were possible to observe and define are presentative age distribution of the galaxies in em-

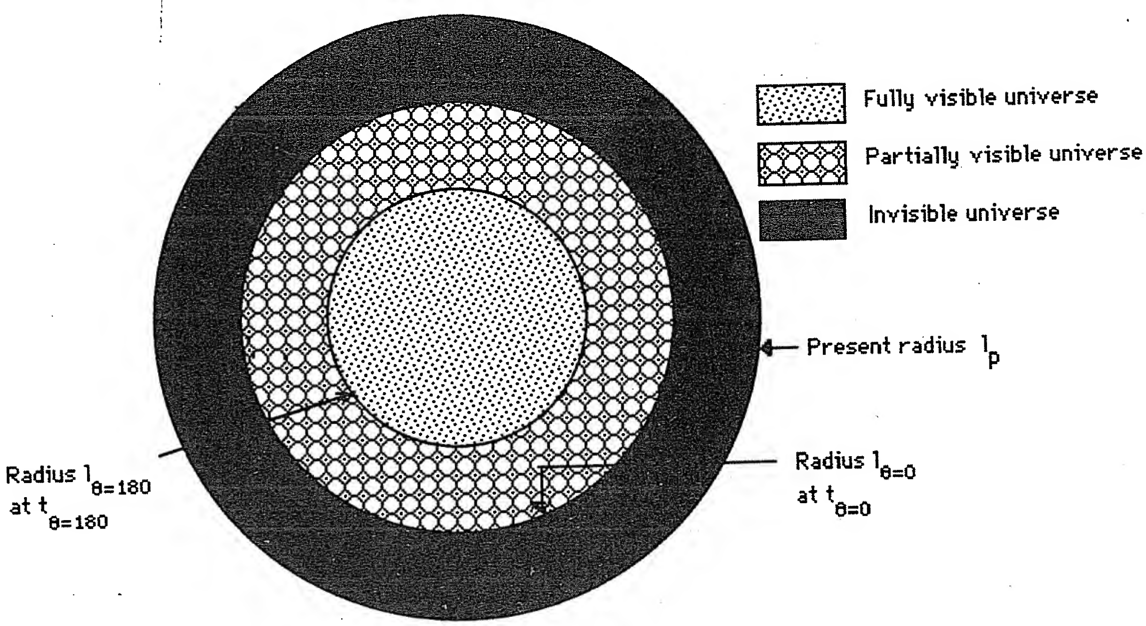

Figure 18. Visible, partially visible, and invisible portions of em-space.

space, we would expect to find in that distribution more of the older galaxies and less of the younger ones. This should be so because, by age, smaller portions of the expanding em-space are visible to us. The distribution could be something like the one shown in the last column of Table VI. Of course, this does not mean that a smaller number of galaxies were born into em-space as it evolved into its present age. It only means that light from some galaxies in the distant past and/or from some younger objects in the far away corners of em-space have not yet had enough time to reach our particular position in em-space.

It should be noted that in this conjecture, in view of the immensely large dimensions of em-space, objects that are born into the same galaxy as observation point OP and even the nearby local group galaxies may be considered to occupy almost the same spot of em-space and are therefore expected to always be visible to each other during their lifetimes, that is, shortly after their births.

9.4 Particular Position of the Milky Way in Em-Space

On Earth, which is an observation point in our galaxy, we are somewhere along one of the radials of the expanding em-space. Depending on the value of α associated with the position of the Milky Way in em-space, we would have a definite value of $t_{\theta=180°}$ associated with the Milky Way as an observation point in em-space. The fully visible universe that we could eventually see with up-to-date technology would be the universe that existed at the time $t_{\theta=180°}$, that is, our "full visibility age." Since the time $t_{\theta=180°}$, em-space has expanded to its present radius of l_p at its present age of t_p.

During the time period ($t_{\theta=0°} - t_{\theta=180°}$), new objects of the matter universe were born into the expanding em-space. At the present age of em-space we should be seeing only decreasing portions of those objects. After $t_{\theta=0°}$ there must be an enormous size of em-space that is probably filled with objects of the matter universe that we do not see. The fact that our visible universe (i.e., the portion of em-space) is populated with galaxies everywhere is a definite indication that the very same conditions extend into the invisible portion of em-space. Figure 18 illustrates the visible, partially visible, and the invisible portions of the matter universe in em-space.

For example, from an observation point associated with $\alpha = 0$, there would still be another portion of em-space beyond the visible universe, comprising a spherical ring of about 3054 Mpc in thickness that is not yet visible. The volume of this unseen portion of em-space associated with an $\alpha = 0$ would be 7 times the volume of the presently observable em-space.

The value of α associated with the Milky Way's location in em-space would determine the size of the universe visible to us now. Similarly, if we knew the absolute size (radius) of em-space visible to us by observing the visible matter universe, we could have an idea about our special location in em-space.

The size of em-space and the embedded matter universe at the age of $t_{\theta=180°}$ for $\alpha = 0$ indicates that at the present age, the maximum size (radius) of the visible em-space would not be greater than 3054 Mpc. This seems to be a curious coincidence because the visible size of the present universe is said to be about 3000 Mpc (Ref. 3, p. 26) in all directions around us. If this is so, it could indeed put our Milky Way right in the center of the TP.

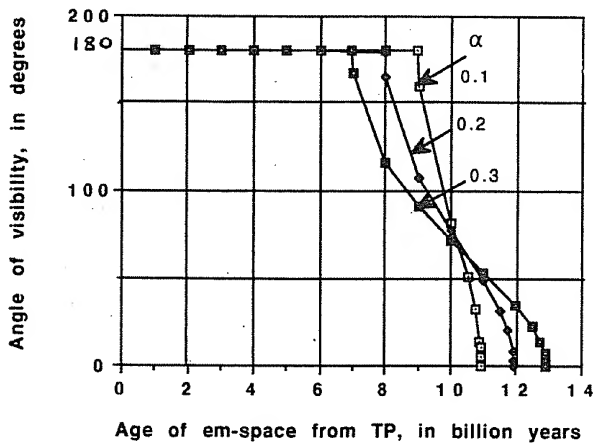

Figure 19. Visibility of universe from an observation point OP associated with α values of 0.1, 0.2, and 0.3.

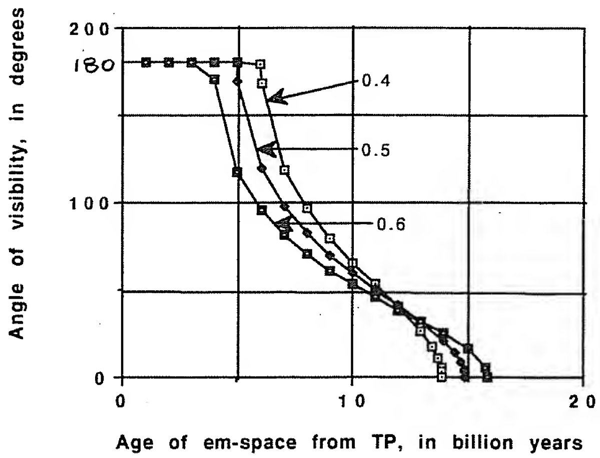

Figure 20. Visibility of universe from an observation point OP associated with α values of 0.4, 0.5, and 0.6.

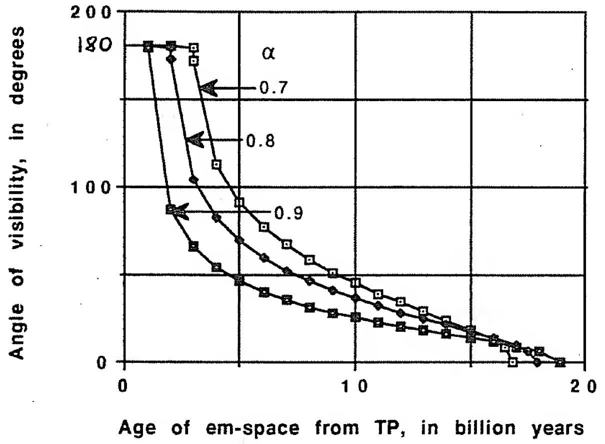

Figure 21. Visibility of universe from an observation point OP associated with α values of 0.7, 0.8, and 0.9.

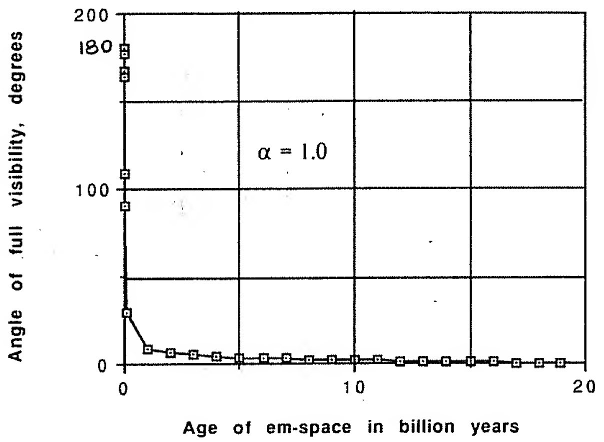

Figure 22. Visibility of universe from an observation point OP associated with α value 1.0.

On the other hand, if the Milky Way were located somewhere other than the center of em-space, then there may be some lopsidedness in the size of the visible universe. In our observations of the visible universe, we have not yet been able to observe the presence of such a lopsidedness in the visible em-space. This may be because of the fact that we were not expecting the visible universe to be lopsided and, therefore, we were not looking for it, or our telescopes did not have sufficient sensitivity. Unless we are indeed in the dead center of the TP of em-space, there should be some un-symmetry in the visible size of em-space as we observe it from our vantage point. Any observed lopsidedness in the visible size of em-space would locate us somewhere way from the center of the TP, thus making the α associated with our location in em-space have a value other than zero. Lopsidedness would show, because objects of the matter universe in some segments of em-space, due to their immense distance from us, are not yet visible to us.

If the Milky Way as an observation point is at or very near the center of em-space, then objects that are 10 billion years and older would fill our total visible sky. In addition, the younger

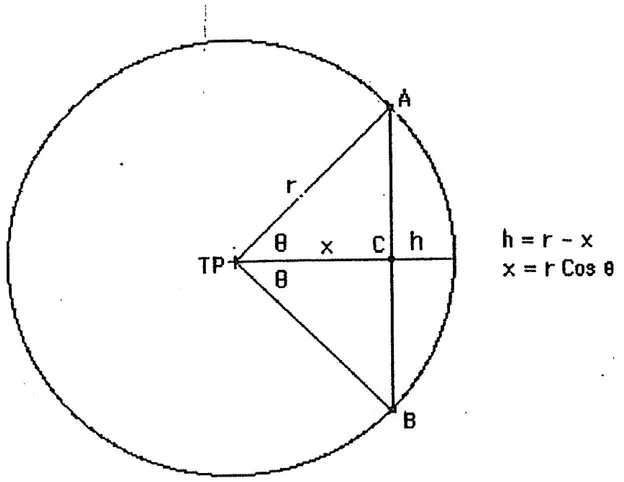

Figure 23. Sector of a spherical em-space.

objects would also be present in the same volume of em-space (i.e., defined by the volume with radius $l_p/2$) except that only those who are born at the age of, say, t, where $t > 10$ billion years and whose distances from the point TP are less than $c(t_p - t)$ would be visible from our observation point.

Table VI: Visible Percentages of the Universe at an OP With $\alpha = 0.5$

Age from TP (in billion yr)	*Billion years ago with respect to t_p*	*θ (degrees)*	*Percent volume*[a]
4.97425	14.94575	179.9	100.00
5	14.92	169.9	99.225
6	13.92	119.1	74.32
7	12.92	97.56	56.58
8	11.92	82.24	43.25
9	10.92	69.98	32.88
10	9.92	59.45	24.59
11	8.92	49.91	17.80
12	7.92	40.79	12.15
13	6.92	31.48	7.36
14	5.92	20.80	3.26
14.5	5.42	13.70	1.42
14.75	5.17	8.50	0.55
14.875	5.045	4.05	0.125
14.895	5.025	2.75	0.06
14.9121	5.0079	0.07	0.00

[a] Percent of the volume of em-space at the stated age from TP that is visible to OP at the present age of em-space, that is, the ratio of the volume of visible sector to that of the total volume at the indicated age.

10. THE INITIAL FRAGMENTATION AND THE OBSERVED UNIVERSE

From the redshift observations made during the last ten to fifteen years, it has become clear that the distribution of galaxies is highly inhomogeneous out to a distance of several hundred million light-years (Ref. 31, p. 106). Large-scale surveys have verified the existence of superclusters of galaxies, that is, super structures that consist of multiple clusters of galaxies (Ref. 32, p. 30) where each cluster, in turn, may be comprised of hundreds of thousands of individual galaxies. Surveys have also shown the existence of equally large regions of space, so-called "voids," where no galaxies are seen.

The popular big bang theory cannot explain this structural appearance of the universe, and probably one of the reasons for this weakness is that it assumes a permanent presence of gravity in the universe. If gravity had existed with its present strength at the birth of the universe and onwards as assumed by the big bang theory, the universe could not have formed into its presently observed state. More likely, the universe would have been killed soon after its birth by the immensely strong gravitational pull that would have existed then.

It is my view that the observed structure of the universe is a verification of the absence of gravity at birth and the negligible gravity that prevailed well into the age of the universe. Consequently, any cosmological model describing the early formation of the matter universe must take this into account.

Calculations based on my theory indicate that universal gravity increased in strength by an order of about 10^{59} times during the first billion years of em-space (i.e., from a value of about 10^{-68} dyn $\cdot$ cm$^2 \cdot$ g^{-2} at Planck time to a value of about 3.35×10^{-9} dyn $\cdot$ cm$^2 \cdot$ g^{-2} at the age of 1 billion years). During the next 2 billion years, it increased about 3 times, and in the following 17 billion years it increased about 6 times. The initial fragmentation of the matter cloud and the large-scale structural formation of the universe therefore probably took place during the first billion years when the most dramatic increase in gravity occurred. Column 4 of Table VII and Fig. 24 illustrate this dramatic change in the value of the universal gravitational constant (UGC).

In view of the notions put forward by the theory presented in this paper, the scenario described in Sec. 10.1 below is a model of fragmentation that would, with high probability, result in the present appearance of the universe.

10.1 A Model for Fragmentation of Homogeneous Matter Cloud

Initially, a hot, dense, and homogeneous matter cloud occupied the volume of em-space during most of the first half million years of its life. Both the matter cloud and em-space were expanding together during this period, while the strength of gravity (UGC) was increasing from its initial value of zero to a new value of about 10^{-11} dyn $\cdot$ cm$^2 \cdot$ g^{-2}. This newly emerging gravity began to act as a form of friction between matter and the fabric of em-space by "coupling" the two together. Although the value of gravity was very small during the early years of formation, the hot and energetic matter particles, moving

Table VII: The Age, Estimated Mass Density of the Matter Universe, the Value of UGC, and the Matter Needed at That Age to Make One Star That Would Have Gravitational Attraction Equivalent to That of the Sun When It Was Born, Say, 5 Billion Years Ago

Age of em-space t (s)	Age of em-space t (yr)	Matter universe $d(\mathrm{g \cdot cm^{-3}})$	Value of UGC G ($\mathrm{dyn \cdot cm^2 \cdot g^{-2}}$)	Matter needed for one star equivalent to UG pull of Sun
0 (TP)	0	—	0	?
10^{-43}	3.17×10^{-51}	8.842×10^{151}	1.0627×10^{-68}	—
10	3.17×10^{-7}	8.842×10^{19}	1.0627×10^{-24}	—
10^{3}	3.17×10^{-5}	8.842×10^{13}	1.0627×10^{-22}	4.729×10^{14}
10^{5}	3.17×10^{-3}	8.842×10^{7}	1.0627×10^{-20}	4.729×10^{12}
10^{7}	3.17×10^{-1}	8.842×10^{1}	1.0627×10^{-18}	4.729×10^{10}
3.154×10^{7}	1.00×10^{0}	2.819×10^{0}	3.3513×10^{-18}	1.499×10^{10}
10^{8}	3.17×10^{0}	8.842×10^{-2}	1.0627×10^{-17}	4.729×10^{9}
10^{9}	3.17×10^{1}	8.842×10^{-5}	1.0627×10^{-16}	4.729×10^{8}
10^{10}	3.17×10^{2}	8.842×10^{-8}	1.0627×10^{-15}	4.729×10^{7}
10^{11}	3.17×10^{3}	8.842×10^{-11}	1.0627×10^{-14}	4.729×10^{6}
10^{12}	3.17×10^{4}	8.842×10^{-14}	1.0627×10^{-13}	4.729×10^{5}
10^{13}	3.17×10^{5}	8.842×10^{-17}	1.0627×10^{-12}	4.729×10^{4}
10^{14}	3.17×10^{6}	8.842×10^{-20}	1.0627×10^{-11}	4.729×10^{3}
10^{15}	3.17×10^{7}	8.842×10^{-23}	1.0627×10^{-10}	4.729×10^{2}
10^{16}	3.17×10^{8}	8.842×10^{-26}	1.0627×10^{-9}	4.729×10^{1}
3.154×10^{16}	1.00×10^{9}	2.820×10^{-27}	3.3513×10^{-9}	1.499×10^{1}
10^{17}	3.17×10^{9}	8.842×10^{-29}	1.0627×10^{-8}	4.729×10^{0}
2×10^{17}	6.34×10^{9}	1.105×10^{-29}	2.1252×10^{-8}	2.364×10^{0}
3×10^{17}	9.52×10^{9}	3.275×10^{-30}	3.1876×10^{-8}	1.576×10^{0}
4×10^{17}	12.68×10^{9}	1.382×10^{-30}	4.2497×10^{-8}	1.182×10^{0}
4.731×10^{17}	15.00×10^{9}	8.353×10^{-31}	5.0251×10^{-8}	1.0
5×10^{17}	15.86×10^{9}	7.074×10^{-31}	5.3112×10^{-8}	9.461×10^{-1}
6×10^{17}	19.03×10^{9}	4.094×10^{-31}	6.3723×10^{-8}	7.886×10^{-1}
$2\pi \times 10^{17}$ [a]	19.92×10^{9}	3.565×10^{-31}	6.6727×10^{-8}	7.531×10^{-1}

[a] These figures represent the case for the present age of the em-space (universe).

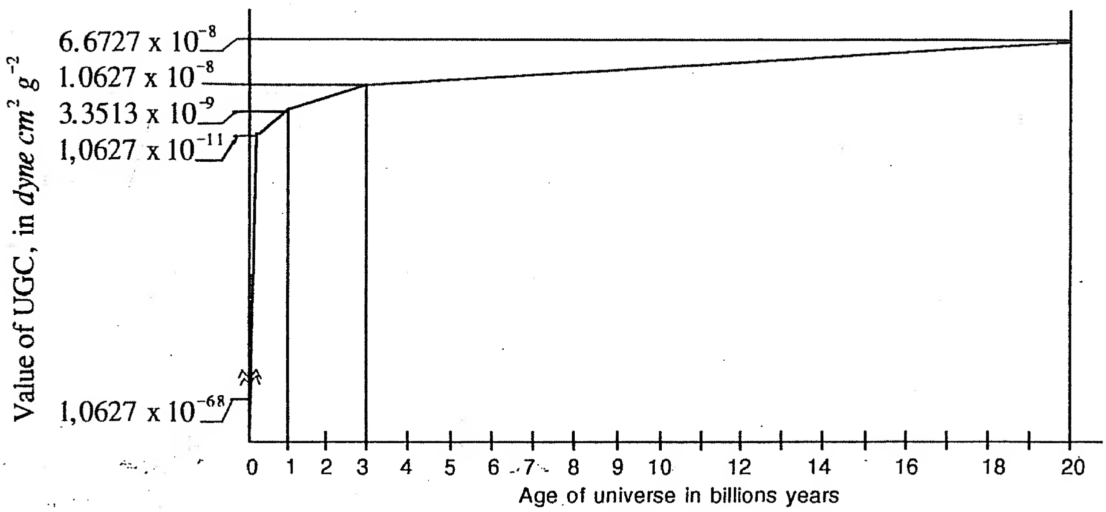

Figure 24. Variation of UGC over the age of universe.

at or near the speed of light within the volume confined by the expanding em-space, would have amplified this coupling considerably due to their relativistic masses. With the passage of time, the matter cloud cooled and the particles slowed down, but the increasing gravity maintained the interaction between matter and the fabric of em-space.

Although the matter cloud and em-space had expanded in unison initially and for quite a while, the gradually increasing gravity in conjunction with the relativistic masses of the matter particles began to oppose the matter cloud's expansion by trying to hold it all together as one unit. So there were two forces affecting the matter cloud: one was the expanding em-space trying to expand the matter cloud with it, and the other was the newly emerging gravitational force that was causing the matter cloud to resist the expansion. The build-up of internal stresses of these two opposing forces would inevitably cause random "cracks" to form along weak zones in the matter cloud.

With the increasing opposition of forces, fragmentation of the matter cloud would take place along stress lines at different locations and at different times. Thus the homogeneous matter cloud that had initially filled em-space would fragment into islands having irregular sizes and shapes.

Each crack would release built-up tension in the matter cloud until a new state of stress developed through further aging and expansion. Fragmentation of the matter cloud in such a manner could and would take place, because while the fabric of em-space is stretchable, that of matter is not.

Through time, these islands of matter would have receded from each other leaving behind little or no matter in the em-space between them. It was these initial large islands of matter that provided the bedding for superclusters of galaxies (see Fig. 25). These large islands would eventually fragment again because of an ever-strengthening gravity and continued expansion, thus creating the environment for the formation of quasars and clusters of galaxies.

Fragmentation of the homogeneous matter cloud in em-space may be likened to the cracking of dried paint on the surface of an inflating balloon. Paint particles are bonded to each other as well as to the fabric of the balloon. As the balloon inflates, the attraction between the paint particles will try to keep the whole paint blotch together while the stretching fabric of the balloon will force the paint blotch to expand until a certain threshold is reached. Then cracking will take place along the weakest stress lines in the paint blotch. Further inflation of the balloon would separate these islands of paint from each other, and more inflation would further break up the already separated paint islands.

The effect of an ever-increasing gravity on the matter islands can be likened to a sieve (a gravity sieve, or separator, if one can call it as such) with increasingly fine filtering ability in time. While the value of gravity at a particular time may have had sufficient strength to cause the collapse of some islands of matter cloud that met a "mass" criterion, other matter islands with smaller mass would have passed through this gravity sieve and continued to expand until gravity became strong enough to halt its expansion and start the process of collapsing into starlike objects. This way, some fragments of matter that passed this screening process, previously because of a lower value of gravity, would at some later time fragment again or pull together and collapse to form a star or starlike object due to an increased value of gravity.

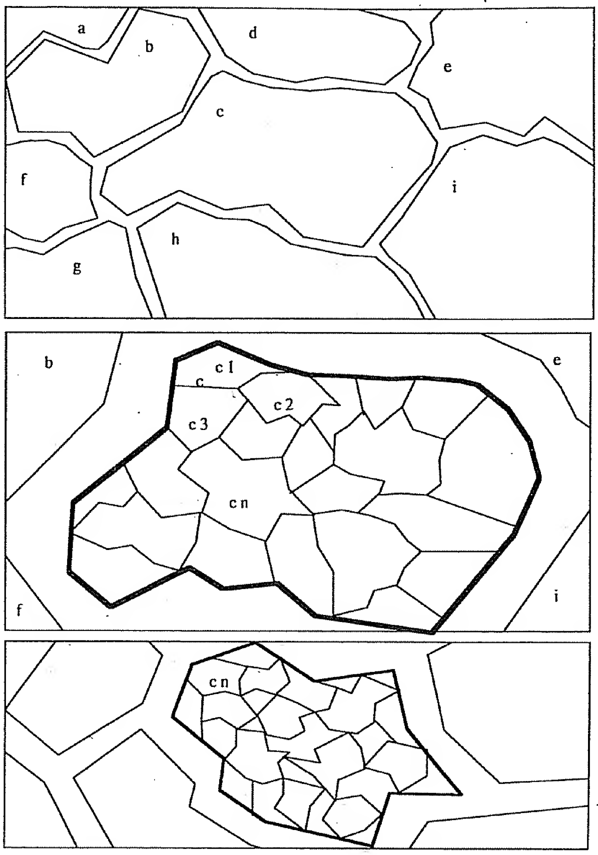

Figure 25. A scenario of fragmentation of matter cloud in em-space.

The implications of such a process are the following:

(1) The islands of gas clouds would retain the original mass content that existed in them at the time of fragmentation and would drift in em-space like icebergs in the sea.
(2) Galaxies that are similar in size and mass will tend to have similar ages.
(3) The larger a galaxy is, the older it will be (earlier formed galaxies will behave cannibalistically and sweep in the material around them).
(4) Stars in an island cloud for a galaxy would not all form at the same time but rather over a spread of time. Larger massed fragments in the bedding of a galaxy would condense and form stars earlier than smaller massed fragments. (A

verification of this process seems to be observed in the Milky Way (Ref. 33, p. 24).

(5) The older stars of a galaxy will be more massive compared to the younger ones, and older stars will tend to be at or near the center of galaxies.

Figure 25 describes pictorially the scenario of fragmentation of the original matter cloud at three different ages: t_1, t_2, and t_3, where $t_1 < t_2 < t_3$. The corresponding values of gravity would be $G_1 < G_2 < G_3$, while the densities of the matter alone in the islands are $d_1 > d_2 > d_3$. The illustration shows a two-dimensional cross section passing through some adjacent islands of matter at ages t_1, t_2, and t_3.

After the initial fragmentation of the matter cloud in em-space, neighboring islands of gas clouds would continue to recede from each other as em-space expands. Throughout the early formation years of the universe, the receding island clouds would clean out large volumes of em-space between them almost to a true vacuum state such that very few celestial bodies, if any, could form in that volume. This could explain why there are large voids where no galaxies are observed.

10.2 Rotation of Separated Matter Islands

Initially, randomly fragmented and formed islands of matter cloud may not have had any rotation to start with, but each would have been surrounded by neighboring island clouds of differing shapes and sizes that would be exerting increasing amounts of gravitational pull on each other due to increasing gravity.

Each island, being surrounded by other islands, would then be influenced by a myriad of gravitational pulls from many directions where even jets of matter may have eventually been forced to leave smaller clouds and join larger ones.

These gravitational pulls and the resulting incoming and outgoing jets of matter (winds) would start motions in the island clouds and eventually cause them to start rotating, each in a particular plane with the direction and speed of rotation being determined by the balance of forces applied to the island. For each island cloud the plane, axis, and speed of rotation would be different from those of other neighboring clouds and would be determined by the size (mass) of the island cloud itself and the locations and sizes of its neighboring clouds. With the increasing universal gravity, the island clouds would become more compact and rotate faster.

10.3 A Scenario for Formation of Stars and Starlike Objects

The process in the scenario described above would also be valid for island clouds that fragment from previously separated island clouds and consequently evolve to form stars or starlike objects. During the process, the size of the islands and their mass density would be expected to be greater in fragments that separate early from the original matter cloud as compared to those that fragment later. Therefore, previously formed island clouds would contain far greater amounts of matter than those separated during later years. For example, an island cloud of matter formed, say, at the age of 10^{11} s (about 3000 yr at which time the value of the UGC was about 1.0627×10^{-14} dyn $\cdot$ cm$^2 \cdot$ g^{-2}) and having the same gravitational pull as our Sun when it formed about 5 billion years ago, would contain as much as 5×10^6 (see Table VII, 4.729×10^6) times the material that coalesced to form our Sun.

Based on the model of em-space and the matter universe presented in this paper, by the age of 1 billion years from $t = 0$, the gravitational pull of such a starlike body could be as much as the pull of at least 315 000 ($= 4.729 \times 10^6/1.499 \times 10$) Suns put together. During those formation years, since such a starlike body would also suck in additional material from the surrounding em-space, it could be equivalent in mass to millions of stars like our Sun. Such a starlike object could be the prototype of "quasars" and having formed at a very early age of em-space would appear very massive and distant from us.

Quasars could have formed only during the infancy years of em-space (i.e., up to the age of about 2.0 billion years) when conditions allowed for large and dense island clouds of matter to exist. During this time, the volume of em-space was comparatively small as was the UGC, but as the universe evolved, sizes of island clouds became smaller while their matter density fell and the formation of such giant starlike objects diminished and gradually became nonexistent.

Table VII provides calculations of the expected values of some of the variables involved during the process of em-space expansion. Columns 1 and 2 give selected ages of em-space, in seconds and years, respectively, after the TP, that is, after the renewal instant of em-space. Column 3 gives the mass density of the matter in the matter cloud at that age (total mass of the matter universe being taken at about 1% of the mass of em-space). Column 4 gives the calculated value of the universal gravitational constant, using Eqs. (57a) or (57b) at that age of em-space. Finally, Column 5 gives the ratio of the gravitational pull of the matter that created our Sun (when em-space was about 15 billion years old, or about 5 billion years ago) to the gravitational pull of the same amount of matter at a different age. In other words, this column gives the amount of matter needed to make a starlike object, in multiples of the matter that coalesced to create our Sun, in order to generate the same amount of gravitational pull as our Sun had when it formed.

As the gravitational constant strengthens with the continuous expansion of em-space, it would be expected that the older a star is, the more massive it should be as compared to our Sun. As a consequence of the growing UGC, older stars would have swept their surrounding em-space clean of matter and hence grown more massive in time. A result of this process would be that older stars would generally be found at or near the center of galaxies, unless they formed at the outer regions of a galaxy and were drawn in towards the center later.

In an environment where gravity is slowly increasing, the compactness of a star or starlike object would also increase with time. A coalescing gas cloud in a lower gravity environment may still have had its nuclear furnace started to form a star (say Star A) but it would not be as compact as a similar gas cloud that coalesces in a stronger gravity environment to form another star (say Star B). By starting out with a slower but gradually increasing burning process, Star A would outlast Star B because Star B would have used up most of its resources quicker because

its burning process started out hotter in a stronger gravity. Stars in globular clusters in the Milky Way and old and massive stars in (or towards) the center of the Milky Way are most likely stars that formed like Star A described above.

10.4 Galaxy Formation

Galaxy formation would be the result of the fragmentation process of the matter cloud in em-space as a result of the ongoing expansion and increasing gravity. Although galaxies embody billions of stars plus the interstellar matter distributed in the volume of em-space where a galactic cloud is located, relatively smaller chunks of matter make up the galaxies as compared to clusters and super clusters of galaxies. In the island cloud that forms the bedding for a galaxy, stars would form first from the interstellar dust and gas and then interact and associate with each other under the influence of the slowly increasing gravity to form the nucleus of a galaxy. Thus a galaxy would start as a loosely associated conglomeration of stars that would evolve through the stages of open spiral arms, to tightly wound spiral arms to elliptical and finally to a globular shape with the increasing gravity. The older a galaxy is, then the tighter its arms would be wound around its central body.

It is a consequence of the increasing UGC that the arms of spiral galaxies become more tightly wound to the central body and that the material in the halo falls towards the center. In so doing, the galaxy must preserve its angular momentum by spinning faster. Thus it would be natural to observe a faster rotation in older galaxies as compared to younger ones.

One of the effects of the increasing gravity would be to make galaxies behave cannibalistically over time. As an example, the Milky Way Galaxy would be expected to attract and assimilate its smaller companion galaxies, the Large and Small Magellanic Clouds.

10.5 Some Implications of a Slowly Increasing UGC on Galaxy Formation

One prominent feature of the theory presented in this paper is that there was no gravity at the beginning of em-space and for quite some time after. A slowly increasing UGC would have dramatically different effects than those of an ever-present and constant UGC on the formation of stars, star clusters, galaxies, local groups, and super clusters of galaxies.

If we consider a universe with a constant and ever-present gravity and the tremendous mass/gravity condition that would have prevailed fast after the big bang, it is highly likely that a "big crunch" would have occurred soon after. If the universe had somehow managed to escape this early death, though, it could have, at some point in time, settled into a state of equilibrium. In this state of equilibrium galaxies either would not have formed at all or they would have taken a much longer time to form than the present age of the universe. Even if the expansion of the universe had somehow prevented the state of equilibrium (thus giving a chance for matter to move about and for gravity to affect galaxy formation), expansion would still have diminished the strength of gravity and its influence on galaxy formation.

On the other hand, a gradually increasing gravity would not have allowed the establishment of a state of equilibrium in the matter universe. Under the influence of a changing and increasing gravity, as is proposed here, the matter universe would be obliged to always be on the move, and therefore the coalescing of matter to form stars, star clusters, and galaxies would take place more readily.

In this model we have a gradually increasing gravity that has taken the total age of em-space to reach its present value. The atoms and/or molecules of the matter universe that were floating freely in em-space have been subjected to a gradual "braking" effect in their movements by a self-centered and slowly growing universal gravitation. During the early formation years of em-space, say the first 3 billion years, the environmental conditions in the universe might be defined in the following general terms:

(1) Em-space was still expanding at the speed of light or very close to it.
(2) Gravity had a very small value compared to its present value. For example, at the age of about 3 million years, it was about 1.64×10^{-4} times its present value, and at the age of 1 billion years, it was 1/20 of its present value.
(3) The volume of em-space was smaller than its present volume. For example, at an age of 1 billion years, the volume of em-space was about 8000 times smaller than its present volume.
(4) The density of the matter universe per unit volume of em-space was greater.
(5) The density of the background radiation per unit volume of em-space was greater.
(6) The energy carried by the background radiation was greater and more concentrated, that is, it was hotter as was the fabric of em-space.
(7) Increasing gravity would speed up the coalescing of gas clouds and the eventual collapse of such material onto a central bulge resulting in the birth of stars and/or star clusters. Hence the central bulge in all galaxies must be the first to form. The total galactic system would rotate altogether.
(8) Because of an ever-increasing gravity, star clusters would start to attract other less massive objects around them to form more massive systems thereby forming the nucleus of protogalaxies.
(9) Protogalaxies would attract more gas and dust, stars, and even some star clusters from the surrounding em-space. The central bulge would grow larger, and spiral arms would begin to form. Such a process would lead to the formation of spiral galaxies. A halo of gas and dust would slowly build up around the overall system from the surrounding em-space.
(10) With increasing gravity, the spiral arms of galaxies would wrap more tightly around the galactic nucleus. Even the nearby smaller galaxies would be attracted and would eventually merge with the most massive galaxies.
(11) As the central bulge grows in mass, the spiral arms with all of their stars and star clusters, gas, and dust would merge with the central bulge of the galaxy, making the form of the

system more elliptical if viewed "edge-on" and circular if viewed "face-on." The gas and dust in the surrounding halo would be swept into the central bulge, thus making the surrounding em-space quite clean of gas, dust, and even star clusters.

(12) Eventually, the overall contents of a galaxy would become so tightly wound around the central bulge that a massive spherical galaxy would form. Some of the bodies within the central nucleus would live out their lives and consume themselves into radiation and eventually black holes.

(13) The evolution process described in (7) to (12) above would also indicate the relative ages of different forms, that is, the spherical galaxies, type E0, being the oldest and the irregular, type Ir, being the youngest.

(14) Projecting into the future of em-space, we may expect local groups of galaxies to merge with each other.

(15) In the distant future all galaxies could be expected to have massive black holes in their nucleus.

(16) But as em-space approaches its maximum expansion (at the age of $t_{max} = (\pi/2) \times 10^{19}$ s, or about 497 billion years), most of the matter universe may become a super galaxy of galaxies. At this point in time the expansion of em-space will stop and the return journey to its origin will start. This will take another 497 billion years (a total of 994 billion years) at the end of which the present half cycle of em-space will end.

10.6 Observations Regarding Galaxies

Systematic observations and classifications of galaxies were done by Hubble in the early 1930s. Rees and Silk[34] give the following account of galaxies in their paper:

> ...The spiral galaxies themselves vary in appearance. At one extreme are those with large, bright nuclei and inconspicuous, tightly coiled spiral arms. At the other extreme are galaxies in which the nuclei are less dominant and the spiral arms are loosely wound and prominent. The elliptical galaxies also form a sequence, ranging from almost spherical systems to flattened ellipsoids. In addition there are highly irregular systems showing very little structure of any kind.
>
> In these sequences there is a parallel progression in certain characteristics of the galaxies. In general, spirals are rich in gas and dust, contain many blue supergiant stars, are highly flattened and rotate appreciably. Ellipticals, by contrast, seem to possess little gas or dust, usually contain late-type dwarf stars and exhibit scant rotation. (Ref. 34, p. 53)

These observations of galaxies seem to agree with the formation of galaxies described above in this theory. For example, the classification scheme developed by Hubble (Refs. 4; 34, p. 55), shown in Fig. 26, would seem to follow the following age pattern: the pattern E0 is the oldest and Sc and SBc the youngest with the exception that S0 could be either the very youngest (i.e., being younger than the type Sc and SBc) or one of the oldest placed somewhere between E0 and E1. It is highly probably that type S0 galaxies are younger than Sc and SBc. That is, type S0 galaxies are advanced stages of star clusters and early stages of types Sc and SBc.

Van den Bergh and Hesser give the following account of NGC 288 and NGC 362:

> The ages measured have helped researchers determine how long it took for the galactic halo to form. For instance, Michael J. Bolte, now at Lick Observatory, carefully measured the colors and luminosities of individual stars in globular clusters NGC 288 and NGC 362. Comparison between these data and stellar evolutionary calculations shows that NGC 288 is approximately 15 billion years old and that NGC 362 is only about 12 billion years in age. This difference is greater than the uncertainties in the measurements. The observed age range indicates that the collapse of the outer halo is likely to have taken an order of magnitude longer than the amount of time first envisaged in the simple, rapid collapse model of Eggen, Lynden-Bell and Sandage. (Ref. 35, p. 75)

With a slowly increasing universal gravity, it is only reasonable that the outer halo of galaxies takes longer to collapse and thus merge with the central bulge of the clusters. If one uses a gradually increasing gravity rather than a fixed and strong value, that is, the present value of the universal gravitational constant G in the "rapid collapse model of Eggen, Lynden-Bell and Sandage," it is only natural that the formation of the halo around the globular cluster NGC 288 takes a longer time to form than the calculated data. Hence the measurements by Bolte are as expected.

The disk of a galaxy, that is, the rapidly rotating equatorial section, being made up of material that is closer to the central bulge of the galaxy than the material in the halo, would rotate faster and hence bulge out (i.e., flatten). Yet the halo (i.e., the spherical and slowly rotating envelope around the galaxy that consists of material much farther away from the central bulge) is expected to rotate slower and also be spherical in shape. The gravitational attraction of the central bulge on the material in the halo is much less than that on the material in the disk. It has slowly increased to its present value and is still increasing. The central bulge has been attracting material onto itself from all directions in em-space ever since the birth and formation of the protogalaxy. Since the density of the matter per unit volume of em-space in the disk is far greater than that in the halo, star formation in the disk is much more frequent than in the halo. Hence more young stars are expected to be found in the disk.

The illustration regarding the "morphological classification" of galaxies, given on p. 76 of Ref. 19, shows galaxy types E, Sa, Sb, Sc, and Ir. The "edge-on" and "face-on" diagrams shown there are very accurate indicators of relative ages of the types of galaxies.

Starting with type Ir, we find that this type of galaxy is young. Both the "edge-on" and "face-on" profiles show that it has not had sufficient time to aggregate material to make

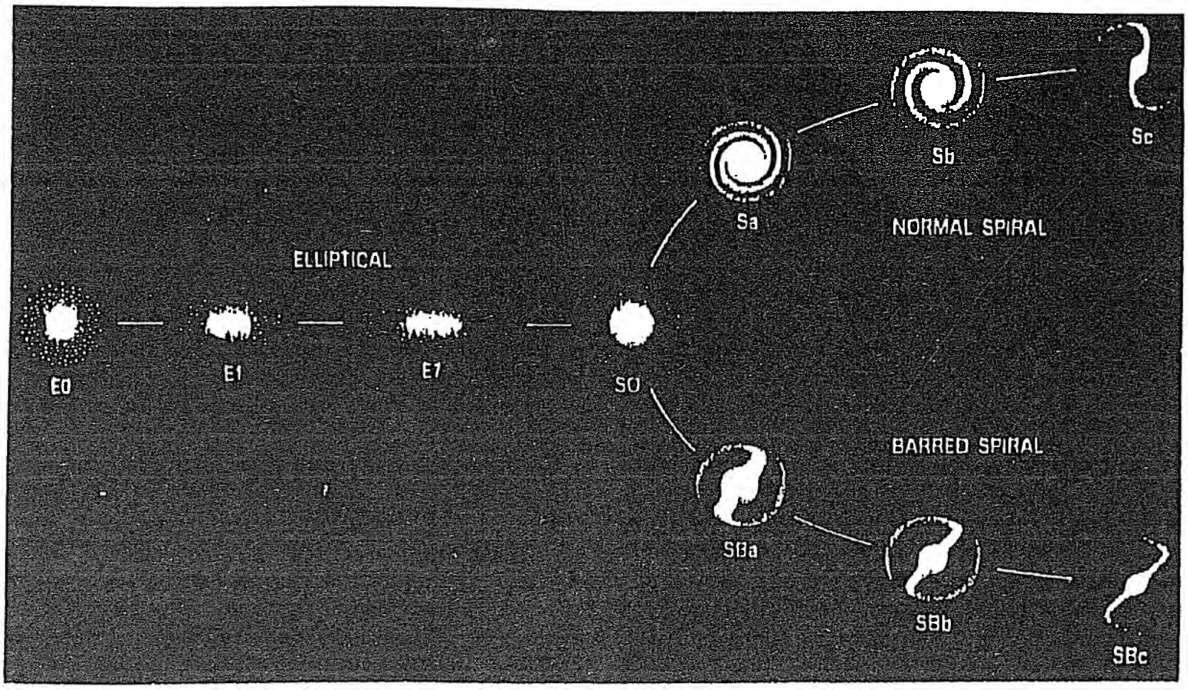

Figure 26. Classification of galaxies developed by Hubble.

a central bulge. Hence the formation is irregular and shapeless. Yet type Sc has already formed into a spiral galaxy because of its older age. Already there is a discernible central bulge with a disk. But not much material from the surrounding em-space has yet merged with the central bulge.

Type Sb is an older galaxy as compared to Sc. Tighter coiling of the arms around the central bulge with the increased size of the central bulge are true indicators of its older age. In type Sa these features are even more prominent because of its much older age as compared to type Sb.

Of course, in the case of a type E galaxy, it is clear that the disk and halo have already merged with the central body, and the surrounding em-space is depleted of its material. The fact that the "edge-on" profile is elliptical and the "face-on" profile is circular is a reminder of its past profiles of an Sa type. The spherical ones may be expected to be the oldest type of galaxies.

The diagrams regarding the rate of star formations with age, associated with each type of galaxy (Ref. 35, p. 76), seem to assume a different rate for each type. In particular, a very high rate for type E and a very low rate for the irregular type during their early ages are assumed. If there was no gravity at the beginning and it took up to the present age to build gravity up to its current value and with type E being the oldest, one would expect gravity to have been weakest during its youth. Consequently, one would expect a low rate of star formation during the youth of type E galaxies, whereas for younger type Ir galaxies the rate of star formation is expected to be relatively higher.

During the early youth of em-space, star formation would primarily be a random process under the influence of a weak universal gravitation, a high background radiation, and a high matter density per volume of em-space. As star formation took place throughout em-space, star clusters would also evolve because of the proximity of evolving stars to each other, more so in some parts of em-space than others. As em-space and the matter universe aged, not only did gravity increase, but so did the number of stars, star clusters, protogalaxies, and even full-grown galaxies. This caused the birth of more stars, star clusters, and galaxies, which in turn caused their speedier evolution. This is expected to happen because an increased number of massive bodies could more effectively influence material in distant regions of em-space.

If gravity had had the same value throughout the age of the universe and if galaxies could have formed, they would have stabilized their structural state within the community of galaxies in em-space and retained their forms for the rest of their lives. With the proposal that gravity has been continuously increasing up to now and will continue to do so for a long

time to come, galaxy forms are bound to change and evolve accordingly. The gradually increasing gravity would raise the gravitational attraction of the galactic center on nearby matter (and even matter in far away star clusters and companion galaxies) and cause it to slowly drift toward the central bulge of the galaxy and merge into one structure. Some galaxies are already in the process of achieving this. Examples are clearly seen among the cluster of galaxies in Hercules given in Fig. 1.16 of Narlikar's book (Ref. 3, p. 17).

11. CONCLUSION

It might be said that we are all part of a universe that lives, ages, and renews itself. Em-space and the embedded matter universe have been perpetuating in this fashion for an eternity and will continue to do so. Its expansion and contraction in a simple harmonic motion must have started quite miraculously in the distant past.

Em-space is omnipresent in our universe. It provides the real estate required for the existence of all things. The matter universe is resident in a sea of its fabric which passes effortlessly through the densest of objects. Even black holes cannot block the passage of em-space through their structures.

The present cosmos will eventually cease to exist taking with it all the information, knowledge, and understanding achieved by life forms in it during that cycle. The new universe will not inherit any knowledge from the previous universe. Perhaps, then, this is nature's fair way of ensuring that all universes start with a clean slate to evolve independently without any influence from previous universes. In a way, I feel that somehow the energy corresponding to the atoms in our bodies will be there to take part in that grand renewal and all that follows.

Acknowledgment
I would like to thank my son Erdem for his continuous moral support and enthusiasm without which this work would have been much more difficult to achieve than it has been. I would also like to note that no human work can be without error or shortcomings. So too is this work. All errors and faults that may be in this paper are mine and mine alone. I ask the readers to forgive me for any inexactness, but more importantly, I hope that they will find something in this work to spark their imagination in this exciting field. Should this happen, I will consider it an achievement in itself.

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Résumé

L'espace-em et le renouvellement de la cosmologie π (un réexamen de l'espace et de la gravité) est une théorie qui touche l'espace, la gravité et la cosmologie. Elle est conçue à partir de deux notions principales. La première notion est que l'espace est faite d'énergie et a donc une masse associée. Le terme "espace-em" désigne cette aspect d'énergie-masse. Cet aspect de l'espace-em est conçu sur : (1) le fait que la gravité existe comme une force universelle. La présence de la gravité indique ici l'aspect principal de l'espace-em; (2) la création de paires virtuelles telles qu'observées dans des conditions du vide de l'espace, et (3) l'existence mesurée de radiation du fond micro-onde cosmique (CBR). Selon cette théorie, le comportement de l'espace-em est comme l'intérieur d'une fournaise géante à température uniforme où la radiation CBR isotropique mesurée est celle du "corps-noir" de la composition de l'espace-em lui-même. Ceci est contraire aux présomptions de la théorie du "big bang" où le CBR est vu comme étant les restes de l'explosion primordiale du début de l'univers.

Cette théorie voit l'espace-em comme étant un système d'énergie-masse contenue et soutenue par lui-même qui oscille en s'élargissant et se contractant pendant une très longue période de temps. La structure de base de la composition de l'espace-em ne ressemble pas à celle de la matière de l'univers. Sa structure étant plutôt flexible, pouvant s'étendre et être résiliente afin qu'en s'agrandissant et s'étendant, elle retient l'énergie potentielle. Durant une grande période de temps, la composition de l'espace-em s'est répandue à travers l'univers d'une manière tellement mince qu'elle n'est pas observable.

La deuxième notion propose que la gravité comme telle n'existait pas quand l'espace-em fut créé, ni l'était-elle pour une période de temps consécutive. Selon cette théorie, la gravité est une qualité inhérente de l'espace-em, débutant à partir d'une valeur zéro quand l'espace-em fut créé et par après s'accroissant lentement en force avec l'expansion de l'espace-em. Cette conception est basée sur le fait que l'univers est en expansion. S'il y avait eu une explosion primordiale conjointement avec l'existence de la pleine gravité, sans considération à la force de cette explosion, rien n'aurait alors empêché la masse dense de l'univers initial de s'effondrer sur lui-même, prévenant ainsi toute expansion et par conséquent son évolution dans l'état actuel. Selon notre théorie, le potentiel de gravité est incorporé dans l'expansion

de la composition de l'espace-em et c'est l'interaction de la matière avec l'espace-em qui a permis à la gravité de se dévoiler. La gravité est la représentation de l'énergie potentielle en réserve accumulée dans la composition de l'espace-em suite à son expansion. Avec l'expansion de l'espace-em, la force de gravité s'accroît et selon cette théorie elle s'accroît à un rythme annuel de 3.3447×10^{-18} *dyn* $\cdot cm^2 \cdot g^{-2}$ *par rapport à la constante universelle de gravitation.*

Cette théorie propose que l'origine du présent cycle de l'espace-em est une énergie singularisée d'environ 20 milliards d'années et non le résultat d'une explosion mais plutôt à cause de sa nature oscillatoire. Le renouvellement périodique de l'espace-em est prédit se répéter à chaque 1000 milliards d'années. Sans gravité pour empêcher son expansion initiale, l'espace-em peut s'élargir à la vitesse de la lumière. Il continuera à s'agrandir jusqu'à ce que toute sa force cinétique aura été convertie en énergie potentielle et incorporée dans sa composition pour ainsi signaler la fin de l'expansion et le début de la contraction.

La matière de l'univers incorporée dans l'espace-em constitue seulement un petit pourcentage (soit de 1% à 2%) de la masse de l'espace-em. Cette "masse" élimine le besoin de trouver la "matière noire" requise pour que notre univers en soit fermé. L'espace-em, avec sa grande "masse" est l'agent contrôleur d'un univers qui émerge continuellement d'un état singulier, qui s'élargie, se contracte et enfin réapparaît une autre fois. L'univers actuel, composé d'espace-em et de matière de l'univers est seulement un cycle de ce système périodique.

La phase de contraction de l'espace-em va terminer dans un état d'énergie singularisé pur où la vitesse de contraction égalisera celle de la lumière, la gravité sera alors non-existante. En considérant la nature cyclique de l'espace-em, ce point sur l'axe du temps a été identifié comme étant π. *Quand l'espace-em passe par ce point de transition, un cycle de l'espace-em finit et puis un autre débute (renouvellement-à-*π*).*

La théorie présentée fournie une autre alternative et répond aux questions posées sur le cosmos et la naissance ainsi que l'expansion de l'univers, l'isotropie du CBR et la formation des super structures de l'univers telles que les quasars et les galaxies.

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